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GOVERNMENT RESPONSIBILITY IN CIVILIAN SCIENTIFIC RESEARCH

IN January 1947, the Advisory Council on Scientific Policy was appointed "to advise the Lord President of the Council in the exercise of his responsibility for the formulation and execution of Government scientific policy". Its appointment has been amply justified, for not merely in the field of scientific man-power but also over the whole range of national economy it has become increasingly important to have a permanent means for ensuring that the scientific resources of Great Britain are effectively utilized in the national interest. The rearmament programme and the demands on scientific man-power and resources likely to result from the implementation of the Colombo Plan and other schemes for the economic development of backward territories in various parts of the world emphasize further the need for an overall survey, in order to ensure that resources are wisely distributed, and also to keep in balance the civil and defence aspects of research policy, as is done by the appointment of a common chairman for the Advisory Council on Scientific Policy and the Defence Research Policy Committee.

Already the work of the Advisory Council during the past four years has shown that opportunities exist for it to watch over and improve the arrangements for securing an adequate supply of scientific workers to meet the needs of the Government and industry, including the provision of adequate facilities for their training, and for the dissemination of information resulting from scientific research; and it is encouraging to note from the fourth annual report surveyed elsewhere in this issue (p. 491) that the Advisory Council appears to have overcome the diffidence with which it approached the man-power situation a year ago, for it has appointed, after consultation with the Ministry of Labour and National Service and the University Grants Committee, a standing Committee on Scientific Man-power. However, apart from special questions, such as those arising out of the use of potentially toxic substances in consumer goods, where the Advisory Council can assist in formulating a common and agreed inter-departmental policy, it is clear from the present report alone that there are other problems in which all the authority and prestige of the Council will be continuously required to avoid distortion of the country's scientific and technical effort and of the use of its resources in directions that may seriously hinder the meeting of other and more important commitments.

This is pointed out by the Advisory Council specifically in regard to demands which may be made upon our resources of scientific man-power in connexion with projects under the Colombo Plan or like schemes. It makes a similar reference in commenting on a report from the Committee on Atomic Energy. The proportion of scientific resources which is now being devoted to atomic energy and nuclear physics in general is a matter of considerable concern, and may well be out of balance. This particular question is one of priorities, and possibly cannot be resolved

even by the Advisory Council on Scientific Policy without some reference to the Defence Research Policy Committee. That may equally apply to some other aspects of national expenditure on civilian research and development which the Advisory Council has at present under review, bearing in mind the restriction on the use of man-power and resources caused by the diversion, in the present economic situation, of so much of the nation's effort to re-armament. The Advisory Council is considering, in particular, the scientific responsibilities which the Government has rightly assumed, and the extent to which government expenditure on civilian research could safely be restricted.

That review is not complete; but in the meantime scientific workers and industrialists will welcome one point made in the present report. Government organizations, like other research institutions, cannot be built up quickly in a stable and effective form. The Advisory Council is convinced that experienced research teams should be kept together in civilian establishments, and that urgent defence work should be assigned to them, rather than that attempts should be made to transfer individuals to defence establishments; in this view the Defence Research Policy Committee and the defence departments have concurred.

Whether or not the review now proceeding foreshadows a considerable curtailment of the research and other scientific services which government establishments are able to offer to industry, the rising costs of equipment, materials and labour are likely to have that effect, even if the establishments of the Department of Scientific and Industrial Research are not diverted to defence work to any considerable extent. Any appreciable increase in the appropriation for civilian research and development must be regarded as unlikely, although the Advisory Council considers it important to maintain a normal rate of recruitment in scientific establishments. Such recruitment will compete with what may be an increasing demand from industry, at least on its rearmament side; but there is no suggestion in this report of what the demand may be from the defence establishments.

These circumstances give special interest to the recently issued memorandum on "Government Scientific Organization in the Civilian Field"*, which embodies the results of a survey which has been conducted by the Council during the past six months. This memorandum traces the growth over the past fifty years, describes the existing organization in Great Britain, and shows the government expenditure on scientific research in the civilian field from 1900 to 1950, together with summarized estimates for 1950–51. While the role of the universities in fundamental research is indicated, no account is taken of appropriations to the universities in the estimate of some sixteen million pounds for government expenditure on scientific research in the civilian field for 1950–51, nor is any attempt made to assess what proportion of the government grants of £11,000,000 for recurrent and £4,000,000 for capital expenditure to the universities in this period could be regarded as for scientific purposes.

The figure cited in this memorandum must therefore be regarded as a minimum, and not as representing the full expenditure by the central Government on scientific work in the civilian field. Nor is account taken of some expenditure by the Ministry of Supply and the Admiralty on scientific research which is preponderantly in the field of defence, but which has a significant application to the needs of civil industry. That by the Ministry of Supply covers the work on atomic energy at Harwell, and probably represents the largest item which could arguably be charged under the civilian head rather than entirely under defence.

The question of the work at Harwell was discussed in a debate in the House of Lords on July 5 on Lord Cherwell's motion to transfer responsibility for work on the development of atomic energy from the Ministry of Supply to a special organization more flexible than the normal Civil Service system and under the direct control of the head of the Government. Lord Alexander's reply was not altogether convincing, and the motion was carried against the Government. Without going into the arguments advanced in that debate, the picture presented in the present memorandum affords some support for the suggestion that the Department of Atomic Energy might well be turned into a separate directorate responsible to Parliament, like other official scientific bodies, through the Lord President of the Council.

The memorandum gives a very clear picture of the organization of government scientific effort in Great Britain and should considerably facilitate the asking of the right questions if any policy of restriction of expenditure becomes necessary. It owes something, indeed, to the earlier statement "Scientific Research and Development" issued in April 1944, to which there is no reference in the bibliography, and it shows how complex is the problem of keeping the Government's research programme in balance. Particularly at a time of financial stringency is it essential to keep in mind two of those aspects which were stressed by the Select Committee on Estimates in its Third Report for the Session 1946–47.

It should lie well within the field of the Advisory Council for Scientific Policy to consider whether the sum appropriated for fundamental research is reasonably related to that allocated to the conduct of applied research and development, though it would require the assistance of other bodies, such as the University Grants Committee, to make such a survey. To determine whether the expenditure on fundamental and applied research is distributed in the best proportion between the several main lines of civil and military research is a task which can scarcely be undertaken except jointly with the Defence Research Policy Committee. Nevertheless, the attempt should be made, and both surveys should take full account of what is being done outside government establishments. So far as applied or industrial research is concerned, government effort should be ancillary and

* Government Scientific Organization in the Civilian Field. Pp. 47. (London: H.M. Stationery Office, 1951.) 1s. 6d. net.

should be in balance with the main effort which is being made in industry itself. Resources of man-power or equipment allocated to government establishments must have regard to what is required in the industries those establishments exist to serve.

While, therefore, the opportunity for the Advisory Council on Scientific Policy has been amply demonstrated, it may be suggested that the Council has been over-conscious of its advisory capacity. On the question of man-power, a year ago it appeared strangely diffident in pressing for the figures required as a basis for concrete recommendations, and it is not clear from the present report that the new standing Committee on Scientific Man-power has received firm instructions. It is difficult to believe that a proposal to which the Council lends the weight of its authority would not have reasonable prospect of early acceptance, and it is to be hoped that no lack of confidence will in future deter the Council from making the firm recommendations in such matters which it is fully competent to make and which the scientific world is entitled to expect of it.

KEPLER THE MAN

Johannes Kepler

Life and Letters. By Carola Baumgardt. Pp. 209+3 plates. (New York: Philosophical Library, Inc., 1951.) 3.75 dollars.

THE main interest of this book lies in the numerous letters of Kepler which are made available for the first time in English translation. They have been selected from his very extensive correspondence so as to depict Kepler as a man rather than as one of the outstanding astronomers of all times. They reveal a very human person who suffered from indifferent health and, as a result of an early attack of small-pox, from permanently impaired eyesight; who was almost always in financial embarrassment, because his salary as imperial mathematician was constantly in arrears (which by 1627 had accumulated to 12,000 florins); who was continually persecuted because of his Protestant convictions; whose work was often interrupted by the disturbed conditions of the time; who suffered from frequent bereavements (only two of his twelve children reached maturity) and from family troubles—including the long persecution of his mother on the grounds of sorcery and witchcraft. The letter he wrote to Scultetus after the death of his wife and of his six-year-old son is a deeply moving document. In very different vein is the amusing letter to Baron Strahlendorf, after he had decided to marry again, describing how difficult it was for him to make a final choice, even with advice from various friends, from among eleven candidates.

In the preface of the book it is stated that this biography of Kepler is the most detailed yet presented to the English-reading public. There is indeed a great need for a comprehensive biography of Kepler in English; this book does not meet that need. The biographical portions are very sketchy; the account of Kepler's scientific work is quite inadequate, and no attempt is made to assess its value. With Kepler a mystical conception of the universe was combined with real scientific insight. Thus, on one hand, in his "Mysterium Cosmographicum" he sought for a relationship between the number and distances of the planets and the five regular solids, convinced in his own mind that there must be an abstract intelligible connexion; on the other hand, he produced works of the greatest importance, such as his "Astronomia nova", in which the first two of his famous laws were formulated, and the "Epitome astronomiæ Copernicanæ", in which emphasis was placed on physical causes and not on arbitrary hypotheses. His third law was enunciated in the "Harmonica Mundi", the main theme of which was to establish an elaborate system of celestial harmonies. Nor is any indication given of how Kepler patiently tried and discarded one hypothesis after another in the attempt to find one that would accord with Tycho Brahe's observations of Mars, until at last he made the momentous discovery that its orbit was an ellipse, so for the first time breaking away from the old Aristotelian conception that the movements of the planets must be compounded of circular motions.

Kepler's interest in astrology was no doubt bound up with his mystical ideas of the universe; he believed that there was an element of truth in it, although it needed to be purged of gross errors. But his 'prognostics' were prepared with his tongue in his cheek; shrewd common sense often enabled him to guess what was likely to happen, so that he gained considerable credit with the vulgar. He was thus able to alleviate to some extent his financial difficulties. In a letter to Mästlin he wrote: "Forgive me, my best teacher. There is much I must apologize for or it would damage my reputation in your eyes. The matter is this: in this calendar I do not write for the large crowd nor for scholars (with a few exceptions) but for noblemen and the prelates, who pretend to have a knowledge about things which they do not understand . . . thus hoping that the readers may be tempted to approve a raise in my salary, which has not yet been increased, just as my expenses have not yet been refunded." Many years later, when writing to Matthias Bernegger about Jakob Bartsch, who was a suitor for the hand of his daughter Susanna, Kepler remarked, "One thing I do not like, he anchors his studies in astrology".

Kepler was in Linz in 1626 when it was besieged, and a sidelight on the conditions during the siege is given in another letter to Bernegger: "With the help of God and his angels, I have survived the siege for fourteen days safely. I did not starve either, even without tasting horse-meat. Only a few had the same good luck." In these more civilized days there are queues often to be seen waiting to obtain horse-meat for human consumption!

Desperate as Kepler's financial straits often were, he repulsed the repeated efforts to induce him to become a convert to Catholicism, although that would have been of great material advantage to him at the Imperial Court in Prague. In a letter to the Jesuit Guldin he wrote that, rather than become a Catholic, "I am prepared to renounce the reward offered to me at present, to which his Imperial Majesty has graciously consented, and to relinquish even the Austrian countries, the whole Empire, and what weighs so much more than all this, astronomy itself. I would add, also, life itself."

It was to the rigours of a journey on horseback from Sagan to Regensburg in stormy wintry weather that Kepler succumbed. The journey was made in an effort to obtain from the Reichstag in Regensburg the salary which had been repeatedly promised to

him and which was so long overdue. His last days were described by an unknown scholar named Fischer: "During the recent meeting of the Reichstag Kepler arrived here on a skinny mare (which he sold later for two gulden). He had been here for just three days when a fever befell him. . . . Soon it increased so that he lost consciousness. As long as the illness lasted, he did not talk like one in possession of his mind. . . . On the 19th [November, 1630] he was buried in the cemetery of St. Peter's, outside the town. For it is not the custom to bury Lutherans inside the walls."

His friends erected a tombstone over his grave with an epitaph he had himself composed:

Mensus Eram Coelos Nunc
Terrae Metior Umbras
Mens Coelestis Erat
Corporis Umbra Iacet.

But within three years the stone was destroyed when Regensburg was conquered by the Duke Bernhard of Weimar in the course of the Thirty Years' War.

This picture of Kepler the man is a valuable contribution to astronomical literature and is of absorbing interest. H. Spencer Jones

RECENT RESEARCHES IN PHYSICS

Physical Society

Reports on Progress in Physics. Vol. 13 (1950). Pp. iv+424. (London: Physical Society, 1950.) 50*s*. net; to Fellows, 25*s*. net.

"REPORTS ON PROGRESS IN PHYSICS", the series of annual reports on recent advances in physics, inaugurated in 1934 and published by the Physical Society, is now an established part of our scientific literature and needs no special introduction or recommendation. It is sufficient to say that Volume 13 is of similar high standard, both in subject-matter and in production, to that of previous volumes in the series. Nine separate topics, covering mainly the experimental field, are chosen for individual treatment in Volume 13. They range from the very border-line subject of physiological optics to the fundamental physics of magnetism.

Three articles deal with various aspects of astronomy. Recent advances in infra-red solar spectroscopy are reviewed by L. Goldberg of the McMath–Hulbert Observatory of the University of Michigan. The way in which the infra-red spectrum between 0·8 and 3·6 μ has been recently mapped, at the Observatory and at Mount Wilson, with a resolution comparable with that which can be obtained photographically, is described. Lead sulphide photoconductive cells and a high-dispersion grating spectrometer were used. It is stated that an atlas of the spectrum, consisting of approximately 250 of the Mount Wilson tracings, each about 70 A. in length, and covering the wave-length region 0·8–2·5 μ, is being published. The post-war developments in radio-wave spectroscopy in the range of wave-lengths of 1 cm.–15 m., particularly the work carried out at the Cavendish Laboratory, Cambridge, are admirably described by M. Ryle of that Laboratory in an article entitled "Radio Astronomy". A shortened and slightly modified version of this report appeared under the same title in the February 1950 issue of *Physics Today*. The report is complementary to the recent excellent surveys of J. S. Hey (*Mon. Not. Roy. Astro. Soc.*, 109, 179; 1949) and J. L. Pawsey (*J. Inst. Elec. Eng.*, Pt. 1, 97, 290; 1950), and therefore more emphasis has been placed on the limitations of the experimental techniques and of the theoretical implications of the observations. Spectroscopic, visual and photographic observations of planetary atmospheres are discussed by G. P. Kuiper, of the Yerkes Observatory, University of Chicago. This article is illustrated by some very fine photographs, taken at the Lowell Observatory, of the planets Mars, Jupiter and Saturn.

Electrostatic generators and linear accelerators were the subjects of separate reports in Volumes 11 and 12 respectively of the Reports. To complete the series, in Volume 13 there is a clearly written and well-illustrated article by J. H. Fremlin and the late J. S. Gooden on particle accelerators, such as the cyclotron, betatron, etc., in which magnetic fields are used for controlling the particle orbits. It is natural to turn from this article with its description of what the new, extraordinarily costly and extraordinarily powerful synchrotrons and synchro-cyclotrons are capable of doing, to the last report in Volume 13, where Prof. C. F. Powell gives an account of the production of mesons in the atmosphere as a result of cosmic radiation, for, as Powell remarks, "even when the new machines have been brought successfully into operation it will still be necessary to turn to natural sources in order to study the nuclear transmutations produced by particles of the greatest energy". The nuclear physicist will regard Powell's and Fremlin and Gooden's reports as of paramount importance.

The longest report, a hundred pages, in Volume 13 is by Prof. E. C. Stoner and is the second half of his survey on ferromagnetism, the first half of which appeared in Volume 11. Under the composite title of "Magnetization Curves", the magnetic properties of single crystals, domain structure, the analysis of magnetization curves, and magnetic materials are treated. The theoretical and experimental work of the past sixteen years is adequately and exceptionally clearly described. There is no need to stress that where magnetism is concerned Prof. Stoner is a master of his subject; but it is worth while commenting that every physicist ought to read this article if only to study the elegant and exemplary manner in which Prof. Stoner collects and marshals his material and writes a technical paper.

Relaxation effects in paramagnetic crystals is the subject of the other report on magnetism in the volume. Experimental methods, namely, absorption measurements at radio frequencies, dispersion measurements and measurements at liquid helium temperatures, and their application to the measurement of magnetic specific heats, are briefly described. In the remaining two articles border-line subjects are dealt with. "Shock Waves and the Propagation of Finite Pulses in Fluids", by W. G. Penney and H. H. M. Pike, is based on work done during the Second World War and contained in papers only recently declassified or still unpublished, and should be extremely useful to workers in this field. "The Investigation of Eye Movements", by M. P. Lord and W. D. Wright, will be of interest to ophthalmologists, psychologists and physiologists as well as physicists.

Attention must be directed to certain changes which have been made for Volume 13. The Reports have been placed under the general supervision of the Papers Committee of the Physical Society, with Dr. A. C. Stickland as executive editor; the detaile l

name index has been discontinued, and a contents list has been provided at the commencement of each Report. The reviewer regrets the absence of abstracts, but welcomes the announcement that it is proposed to supplement the cumulative name index for Volumes 1–7, already published, by a cumulative index for authors and subject-matter for all the volumes up to date. S. WEINTROUB

AMERICAN RESOURCES

Conservation of Natural Resources

Edited by Guy-Harold Smith. Pp. xii+552. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1950.) 48*s*. net.

"RESEARCH Conservation" now appears in the curricula of many American universities. It is an indication of the increasing realization that the natural resources of the world in general, and the United States in particular, are far from being inexhaustible, and that serious attention should be paid to their conservation.

The subject as taught in the universities is, in fact, economic geography, dealing in turn with each of the main products required by man, but to which is now added an assessment of reserves and an account of the steps which are taken or should be taken to maintain supplies, so leading into the field of State and local planning.

The book under review deals exclusively with the United States and is the co-operative effort of twenty authors under the general editorship of Prof. Guy-Harold Smith, professor of geography in the Ohio State University. It is divided into eight parts, comprising twenty-three chapters. The first chapter, by A. J. Wright (Ohio State University), deals appropriately with the development of conservation in America, and is followed by Chapter 2, "The Public Domain and its Disposal", by S. S. Visher (Indiana University).

Nearly every visitor from the Old World to the New is struck at once by evidences almost everywhere of profligate waste of land and resources. In Britain where the total area of land of all sorts is only a little more than one acre per head of population, conservation has been automatically a part of the British way of life for many centuries. It is difficult to appreciate what has happened in the United States over the past hundred years, where the exposure of vast tracts of former forest and grassland to the evils of soil erosion by indiscriminate clearing and ploughing has led to the abandonment of millions of acres. It is greatly to be hoped that the evils of the present position there will be fully appreciated before the same forces of destruction are let loose in the so-called under-developed lands of Africa and South America.

Part 2, occupying a major part of the book, deals with soils, soil conservation, tree crops, irrigation, grassland, marsh-reclamation and the agricultural prospect. Part 3 deals with forests, Part 4 with water in its different aspects, Part 5 with minerals, including fuel, Part 6 with wild life and fisheries. Part 7 comprises a chapter on recreational resources and a chapter by the late Ellsworth Huntingdon on the conservation of man and what he called the "geography of the human crop". He draws the conclusion that at present the quality of the American people is declining and that little attention is being paid to the decline. Finally Loyal Durand (Tennessee) deals with State and local planning, and the editor with national planning and the conservation of resources. He rightly stresses the continuing need for research and refers to the United States as a country of diminishing material resources, but where there are still new frontiers to be explored. The United States is passing from the phase of extensive, carefree use of land, to an intensive, careful one.

This volume is a scholarly, objective and timely survey of the whole field; it is fully illustrated by maps and diagrams and adequately documented.

L. DUDLEY STAMP

SCIENTIFIC PHOTOGRAPHY

Wissenschaftliche Photographie

Eine Einführung in Theorie und Praxis. Von Prof. Dr. E. v. Angerer. Vierte Auflage. Pp. vii+226. (Leipzig: Akademische Verlagsgesellschaft Geest und Portig K.-G., 1950.) 13.80 D. marks.

Photography in Astronomy

By Dr. E. W. H. Selwyn. Pp. 112. (Rochester, N.Y.: Eastman Kodak Company, 1950.) 2.75 dollars.

CONSIDERING the wealth of fundamental physical and chemical problems underlying photographic practice, and the many diverse fields of research in which photography is such a valuable —sometimes an indispensable—tool, it is remarkable that there is such a dearth of good general texts on the subject in the English language. In the opinion of the reviewer this is closely connected with the neglect of photography as a subject of study, whether from the scientific interest of its underlying theory or as a branch of technology deserving of scientific analysis, in British universities and higher technical colleges. Certain it is that the position has long been different in Germany and Austria, as the mere mention of such names as Eder, Lüppo-Cramer and Luther will serve to remind us.

The author of "Wissenschaftliche Photographie" is an associate professor at the Technische Hochschule at Munich, and his well-known book (first published in 1939) is a good example of the sort of text we need. Its virtues lie especially in its method of approach to the subject—an approach calculated to appeal to the serious student, and to the research worker who wants something more than a 'cookery book' to guide him in his use of photography as a tool. Yet it is not an exhaustive text by any means, but only an introduction to the subject; and for this reason, perhaps, this fourth edition does not differ very markedly from earlier editions. It is excellently produced and moderately priced.

In the absence of academic texts in English, the photographic industry itself has sought in recent years to fill the gap: Dr. C. E. K. Mees's "Theory of the Photographic Process" and Dr. Walter Clark's "Photography by Infra-Red" will come to mind in this connexion. Dr. Selwyn's book on astronomical photography is another excellent, though slender, text from the same source. It is essentially readable, superbly illustrated, and very well produced; and the fact that it comes from one particular industrial company is not obtrusive. The astronomer may find it a useful summary, the student in other fields will certainly learn much from it; but both will no doubt regret its omission of references to original work.

L. V. CHILTON

Statistics

An Intermediate Text Book. By Dr. N. L. Johnson and H. Tetley. (Published for the Institute of Actuaries and the Faculty of Actuaries.) Vol. 2. Pp. xi+318. (Cambridge: At the University Press, 1950.) 20*s*. net.

STATISTICS is now an important part of the course of training for actuaries. The Institute of Actuaries and the Faculty of Actuaries have consequently arranged for the preparation of this book for the use of their students.

This second volume, which completes the work, has three chapters on the general theory of distribution functions, their application to particular types of sampling and the multinomial distribution (leading to χ^2). There follow chapters on the general theory of statistical tests and estimation, stratified population and variance analysis, correlation analysis and curve fitting, and graduation. The exercises at the end of each chapter and the end of the volume are numerous and well chosen. That the book emanates from the Cambridge University Press is sufficient guarantee of the quality of the printing; and the price, in present circumstances, is quite reasonable.

The defects of the book—it is perhaps scarcely fair to describe them as such—are inevitable in any attempt to compress statistical theory into a comparatively brief compass at the University Intermediate level. There is only space, for example, for two and a half pages on least-squares estimation, and less than that for maximum likelihood. On the other hand, there are sections on topics which have not yet found their way into standard texts, such as the supplementation of the χ^2 test by tests of changes of sign. Notwithstanding the limited objective of the book, it should also form a useful intermediate text for non-actuarial students.

Trace Elements in Plants and Animals

By Prof. Walter Stiles. Second edition. Pp. xi+189+8 plates. (Cambridge: At the University Press, 1951.) 15*s*. net.

THE demand for a concise and reliable account of the part played by trace elements in the nutrition of plants and animals is shown by the issue of a second edition of Prof. W. Stiles's useful book on the subject. The text remains for the most part unchanged, though a number of supplementary references and a photograph illustrating molybdenum deficiency in cauliflower have been included. In view of the rapid progress that has been made in this field it seems a pity that the opportunity was not taken to extend the section on molybdenum deficiency in plants a little further, and that no references later than 1948 have been quoted. K. W.

Flora of Egypt

Vol. 2: Angiospermæ, part Monocotyledons; Cyperaceæ–Juncaceæ. By Vivi Täckholm and Mohammed Drar. (Fouad I University: Bulletin of the Faculty of Science, No. 28.) Pp. xii+547. (Cairo: Fouad I University Press, 1950.)

NINE years have elapsed since the publication of the first part of this work. The second volume covers the sedges, palms, aroids, rushes and some related families. The Flora is considerably more comprehensive in scope than most works of its kind, for, in addition to the systematic account of indigenous plants, cultivated species and many garden plants are included. All plants of importance in Egypt, either because of the uses to which they are—or used to be—put, or because of their connexion with ancient cultures, receive an unusually detailed treatment which embodies much historical, archæological and other information of interest and value. There are also copious references to literature relating to all the aspects discussed. Particularly detailed accounts are given of papyrus and date palm, in which the importance of these plants is described in relation to art, literature, religion and ancient industries. It is therefore not surprising to find that, in this volume of more than 500 pages, only seventy native species are included. The account of the palm family, for example, runs to nearly 200 pages, though only the date, dom and argoun palms are extensively grown and are important species, and only one of these is indigenous. The many other exotic species included are all cultivated plants. It is greatly to be hoped that future parts will appear at more frequent intervals, and that it will be possible to complete the work on the scale and with the thoroughness foreshadowed by the first two volumes. W. A. S.

Die naturwissenschaftliche Illustration

Ein geschichtlicher Überblick. Von Claus Nissen. Pp. 64. (Bad Münster am Stein: Lothar Hempe Verlag, 1950.) n.p.

THIS little book surveys a very large subject—the history of animal and plant illustration from classical to modern times. Such a work must deal with questions of art, illuminated MSS., the evolution of the printed illustration, the woodcut, line engraving and etching on copper, lithography, and finally the numerous processes based on photography by which illustrations in black and colour can be produced. It is obvious that a small octavo booklet of only fifty-six pages can only explore so vast a field in the merest outline. Dr. C. Nissen's contribution, however, will be very useful to the beginner in setting him on the road to more detailed information. Skeleton bibliographies are added. F. J. C.

The Subject Index to Periodicals, 1949

Issued by the Library Association. Pp. xi+296. (London: Library Association, 1951.) 105*s*.

SINCE the outbreak of war in 1939, the "Subject Index to Periodicals", of which the 1949 volume has now been published, has dealt only with periodicals in the English language, which are published in Great Britain, the Dominions and the Colonies, excluding Canadian periodicals, which with American periodicals are adequately covered by the H. W. Wilson Company's indexes. Highly specialized periodicals in science or technology are also omitted and the "Subject Index" thus caters chiefly for the general reader, offering him a key to the contents of many periodicals which are not indexed elsewhere. Among these are some devoted to subjects of limited appeal such as stained glass or mountaineering, and also the proceedings and transactions of local societies concerned with antiquities, natural history, etc. The "Subject Index" is compiled on the plan of the 'dictionary catalogue', all entries being in simple alphabetical order. Articles relating to people, places, institutions, etc., are placed under the proper names in question, while 'subject' articles are entered under simple, practical headings, which describe, as specifically as possible, the material in question. Cross-references are freely used for linking up related subjects, and where necessary titles are elucidated by admirable explanatory annotations. The production and layout maintain the high standard set by previous volumes of the "Subject Index".

AURORAS AND LUMINOUS NIGHT CLOUDS*

By J. PATON
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Auroras

SCOTLAND is well situated for observing auroras for they may be seen there on the average on about forty nights in the year, compared with seven to ten nights in the south of England. Since 1946, four stations—at Abernethy and Blairgowrie in Perthshire, Newton Stewart in Wigtownshire and Roseneath in Dumbartonshire—equipped with specially designed cameras ($f/1{\cdot}25$ and focal length 5 cm.) and linked by telephone, have been used to record the forms and to determine the positions and heights of auroras that have occurred in association with the last sunspot maximum of 1947.

It is impossible to predict precisely the course of a great aurora, but what usually happens is as follows. At first, a glow, much like dawn (hence the name aurora borealis, northern dawn, which was first used by the French philosopher, Gassendi, in 1621), appears on the northern horizon, often with a warning by day 24–36 hours beforehand of a solar flare. The glow then ascends from the horizon to form an arc, the lower border of which is at a height of about 100–110 km. Of all the auroral forms, the quiet arc is the only one of which the lower border appears always at about the same height; there is no significant variation either with latitude or with local time. This fact, together with the tendency of the arc to remain quiescent for a long time, allows the determination of its geographical position by photographs from a *single* station. In fact, when such an arc appears, there is an arrangement at the Scottish stations to photograph simultaneously according to a prearranged time scheme with Prof. Carl Störmer's Scandinavian network. The geographical position of the arc may then be plotted from mid-Atlantic to western Russia, thus providing information that may be of value to the theoretical worker.

The true colour of most arcs is probably green, for a predominant line in the spectrum is the green forbidden line 5577 A. of atomic oxygen, and this happens to be in the region of maximum sensitivity of the retina. But, except in the case of very bright arcs, it appears to the eye to be grey-white, since the light intensity is below the threshold of colour perception. The arc may then brighten suddenly to an intensity above the threshold such that patches of vivid greens and reds can be seen here and there along its length. Simultaneously the lower border becomes extraordinarily sharply defined and is appreciably lower, all of which are signs that the arc is about to lose its regular shape and to show ray structure. It may then undulate to appear like the folds of a huge waving curtain, or it may take the form of a wide band, stretching irregularly across the sky. The base of these draperies may come as low as 90 km.; the minimum height tends to occur at about 0300 hr. local time, so that the particles which cause auroras appear to penetrate most deeply into the atmosphere about this time. There is some evidence, too, that the bases of curtains and bands are lower in lower latitudes. Indeed, one of the aims of low-latitude stations, such as those in Scotland, is to investigate these latitude variations.

When the rays pass overhead into the southern sky, they then form what is undoubtedly the most spectacular of auroral forms—the corona. The rays appear to converge to a point, approximately the point in the sky to which the south pole of a magnetic dip needle would point—in Scotland it is about 20° south of the zenith. Thus the direction of the auroral streamers coincides approximately with the lines of force of the earth's magnetic field. This is what would be expected if the aurora is caused by charged particles emitted from the sun at the time of the flare, for, when they eventually enter the earth's magnetic field after their journey of a day or so through space, the particles would be deflected to travel ultimately either directly down the lines of force or in close spirals round and down them. The auroral light is produced along their path by the excitation of atmospheric atoms and molecules, probably mainly by collisions with secondary electrons ejected by the primary auroral corpuscles. The light streamers are therefore closely parallel and their apparent convergence in the corona is merely the effect of perspective.

When the display is at its height, the total illumination may be greater than that of full moon. During the great display of January 25, 1949, it was possible to pick out trees and fields on a hillside three miles away. At one point during this display the illumination suddenly ceased as if the lights had been switched off; but a great display usually fades out in what is called 'flaming'—waves of light, generally of low intensity, surge upwards, one after the other, towards the zenith. Sometimes this whole sequence may be repeated. There is a fairly well-marked diurnal variation with a main maximum at 2200 hr. and a secondary one at 0400 hr. Usually, luminosity is greatest and the auroral forms are most active and well defined at the time of the main maximum, and it is then that the display is likely to reach its most southerly limit. At the time of the secondary maximum, the forms are often diffuse and weak.

The method of determining the height and position of aurora is due to Prof. Störmer, who, besides making important contributions to the theory of aurora, has, during the past forty years, made a very thorough investigation of auroral forms seen from Norway. A certain part of the aurora is photographed simultaneously by the observing stations, and then, on comparing the plates, the relative parallax of the star background is measured and the location of the aurora computed. During the great aurora of January 25, 1949, a base line of 169·8 km. was used between Abernethy and Newton Stewart to measure the height and position of red diffuse surfaces, which were found to be situated at heights of 500–700 km. over northern Germany. As might be expected, the main difficulty has been cloud and fog, which have completely obscured at least two great auroras, and often obscure an aurora at one of the stations when the others are able to make an exposure.

Luminous Night Clouds

The auroral cameras and plates are suitable for the photography of the rare noctilucent or luminous night

* Substance of a paper read on August 9 before Section A (Physics and Mathematics) at the Edinburgh meeting of the British Association.

clouds, so that when the brilliantly blue clouds were observed on July 10–11, 1949, parallactic photography was immediately begun and continued until the clouds slowly vanished in the growing light before dawn. Measurements showed that the whole mass of cloud was situated at heights between 84 and 89 km. and was confined within the twilight circle. (The greatest height at which ordinary clouds appear is about 12 km.)

It is most surprising that the first records of these remarkably lovely blue clouds appeared as late as 1885. Their spectrum is similar to that of the day sky and shows Fraunhöfer lines; the particles constituting the cloud then are so high that those within the twilight circle are in sunlight, revealing their presence by the sunlight they scatter. Their blue colour indicates that the diameter of their particles is small compared with the wave-length of light.

The conditions necessary for observation of the clouds are as follows: the sun must be at least 10° below the horizon in order that the sky background may be sufficiently dark; it must not be more than 18° below the horizon, for an appreciable part of the atmosphere above 80 km. must be in sunlight; normal clouds must be sparse or absent and visibility excellent. Thus they can be seen only in the summer months and only within latitudes 45°–62°.

The first accurate measurements were made in Germany by Jesse about 1890. He found their height to be about 79–90 km., and on one occasion recorded the remarkable velocity of 177 m. per sec. or 400 m.p.h. He observed that they travelled from the north-east before midnight and from east-north-east after midnight. They occurred frequently and in brilliant forms during 1885–88. Omond saw them from Ben Nevis Observatory on every clear night from June 4 to July 2, 1888. From then until 1932 they were seen only occasionally. During 1932–34 the clouds again appeared in brilliant forms to give Prof. Störmer the opportunity of applying the technique that he had used so successfully in studying auroras. He confirmed Jesse's measurements, finding the mean value of their height to be 82 km. and their velocities to lie in the range 48–83 m. per sec. The clouds were rarely seen between 1934 and 1949, but during and since 1949 several fine displays have been photographed and measured both in Norway and Scotland. On July 24–25, 1950, the rare coincidence occurred of luminous night clouds in association with an aurora. On this occasion the clouds soon became so brilliant that they extinguished the aurora. By 0100 hr. they extended along the horizon between azimuths 345° and 85° and reached an elevation of 25°; at this time, so brilliant were they, that it was possible to make notes and observe the stop watch by cloud light.

The nature and origin of the clouds is still uncertain. Jesse thought them to consist of the products of condensation of matter projected into the high atmosphere at volcanic eruptions; the magnificent displays of 1885–86 were ascribed to residual dust from the Krakatoa eruption of 1883. But Vestine has pointed out that just at this time there occurred a remarkable number of meteor appearances, showers and great comets. Moreover, no marked increase in the frequency of the clouds succeeded the eruption in 1912 of Katmai, Alaska, whereas the great Siberian meteor of 1908 was followed immediately by a brilliant display. So he concludes, and Prof. Störmer agrees, that the clouds consist of material of cosmic origin.

On the other hand, Vegard believes that the clouds may be formed by the condensation of water vapour on sodium oxide nuclei formed by the combination of sodium and atmospheric oxygen. He suggests that the presence at this great height of water vapour, in the concentration necessary to account for such extensive clouds, may result from the combination of atmospheric oxygen, perhaps in the form of ozone, and hydrogen, projected into the atmosphere from the sun. There is evidence that a temperature minimum of the order of 200° K. exists at a height of 80 km., and, as the pressure there is of the same order of magnitude as the vapour pressure of water, conditions may be favourable for condensation. During the display of July 24–25, 1950, portions of the clouds were observed to change colour from vivid blue to white, suggesting growth of the particles.

Now that Whipple's meteor observations and the theoretical work of others on atmospheric tides indicate that temperature falls rapidly from a maximum at 60 km. to a minimum at 80 km., the problem of explaining the occurrence of the clouds always at about 80 km. is resolved. Meteoric dust, for example, would tend to drift to and remain below the base of the inversion at 80 km., and if these are water clouds, then condensation is most likely at the temperature minimum at 80 km. Indeed, the presence of the clouds always at this fixed level is itself evidence of the existence there of a temperature minimum.

Wave formation is a characteristic of the clouds, and measurements show that the distance between the wave crests is about 9 km. Recalling the great speeds with which these clouds may travel, the wave formation is no doubt generated in the wind shear at the inversion, as in ordinary billow clouds.

These clouds are naturally of great interest to the meteorologist for, with meteor trains and now the new radio methods, they provide a direct means of measuring air movement at these high levels.

STORAGE OF FARM PRODUCTS

IT is often not realized that an increase in the yield of a farm crop which has taken many years of selection and improved culture to achieve may be much less than the losses during storage of the crop. For example, it has been estimated that a fifth of the total production of potatoes in France is lost during storage because of respiration, water-loss, disease and sprouting. There seems no reason for believing that the overall loss in Great Britain is much less, in which case the weight lost during storage would be sufficient to supply the whole human population of the United Kingdom for nearly four months. Admittedly potatoes are one of the more impermanent farm crops; but for most products the development of more efficient means of storage is a matter of great importance, and clearly merited the discussion devoted to it at Edinburgh by Section M (Agriculture) of the British Association during the morning of August 10 under the chairmanship of Dr. E. M. Crowther, president of the Section.

Prof. S. J. Watson, of the Department of Agriculture and Rural Economy, University of Edinburgh, speaking first, discussed the storage of grass. The traditional method—by making hay—is extremely wasteful of the feeding potential of the grass. In a wet year as much as half the feeding value may be

lost by various means—as by respiration during the comparatively slow drying process and by leaching. Even in an exceptionally fine year about a quarter of the nutrients originally present is lost. The average loss is about a third. The use of appliances, such as stakes, wires, and tripods, on which the grass is placed after cutting reduces these losses but only by about 5 per cent. On the average, ensiling without any addition is as wasteful as haymaking in an average year, though it must be remembered that silage and hay are not comparable, the former being made from younger and more leafy material. The various forms of fermentative losses during ensiling may be reduced if the *p*H is low, preferably below *p*H 4, and it has been claimed that the losses are very slight if silage is made with the addition of acid. The beneficial effect of the acid tends, however, to be local. Possibly the best practical method is to use a roofed and lined pit silo and achieve a certain degree of acidity—say *p*H 4–4·5—by the addition of molasses and the consequent lactic acid fermentation. This acidity is sufficient to suppress butyric acid fermentation.

By far the most efficient means of conserving the feeding value of grass, Prof. Watson said, is to dry it artificially. The net feeding value may be of the order of 7 per cent less than that of grass, due mainly to the greater loss of energy in the mastication of dried, as compared with fresh, grass. The disadvantages of grass drying are economic; but Prof. Watson agreed in the course of subsequent discussion that such disadvantages might not be important if the drying were undertaken on a large scale by a competent factory manager. Broadly speaking, he recommended drying for the large-scale preservation of grass and, on the small scale, ensiling in either pit silos or good tower silos. Hay would still be made, and every care should be taken to keep the losses to a minimum.

Following Prof. Watson, Mr. J. H. Leycester, of Wheatfield, Hilton, Huntingdon, described the method which he has developed for storing grain, explaining that it had been planned to meet his own requirements for the storage of about four hundred tons of wheat and barley. The system followed is not to harvest the grain moist and then dry it, but to wait for dry weather and harvest twenty tons a day using combines with a total cutter-bar length of twenty feet. The grain is delivered in bulk by pneumatic tipping lorries to the store, which consists of a receiving bin (with a floor sloping to the outlet and feeding by gravity into a pneumatic conveyor), a cleaning unit and eight 40-ton storage bins. No dryer is installed—this being a useful selling-point when disposing of the barley for malting. In years when the grain has necessarily been harvested wetter than advisable, drying down to 16·5 per cent moisture has been achieved by repeatedly passing the grain from one bin to another through the pneumatic conveyor. Passage once through the conveyor has been found to remove 0·25–0·5 per cent of moisture at a cost of 2·2d. per ton. (In answer to questions, Mr. Leycester stated that this is the cost of electricity only.) He agreed that a moisture content of 16·5 per cent is higher than normally regarded as advisable, and only exceptionally does he store grain at a moisture content as high as this. The stored grain is shifted from one bin to another during storage at intervals of 6–7 weeks, one bin being kept empty to enable this. Asked whether, in the light of experience, he could suggest improvements to his store, Mr. Leycester replied that it would be better if it were excavated to a depth sufficient to avoid the necessity for a loading ramp from which the receiving bin is now filled. Higher storage bins and a conveyor of greater capacity would be preferable.

The further proceedings of the meeting were devoted to the storage of potatoes. Mr. W. G. Burton, of the Ditton Laboratory, East Malling, of the Department of Scientific and Industrial Research, outlined the ideal conditions for the storage of potatoes but stated that these were attainable only in heavily insulated cool stores with continuous air circulation. These are not at present thought economically justifiable. Potatoes stored at normal temperatures generate sufficient metabolic heat to raise their temperature 0·6–0·8 deg. F. per day. In a stored mass of potatoes a state of dynamic equilibrium is set up in which heat removed by convective air circulation and conduction, both of which result from the difference in temperature between the potatoes and the surrounding atmosphere, just balances the heat produced by respiration. At normal storage temperatures of 40–50° F. and for unsprouted tubers it is approximately true to say that, if the width and length of an unventilated potato stack exceed twice the height, increasing them has little effect upon the average and maximum temperatures; that the average temperature of the potatoes will exceed that of the store air by ⅔ deg. F. for every foot of height; and that the maximum temperature among the potatoes will exceed the average temperature of the store air by 1 deg. F. for every foot of height. The provision of ventilating ducts beneath the potatoes lowers both the average and maximum temperatures, and further cooling is possible if forced ventilation with a power-driven fan is employed. Continuous forced ventilation at a rate of 2,300 cu. ft./ton hour will remove about 110 B.Th.U./hr. deg. F. difference in average temperature between the potatoes and the ventilating air, and with air at a steady temperature will maintain stored potatoes at an average temperature exceeding the inlet temperature of the ventilating air by about 1 deg. F. and with a maximum temperature less than 1 deg. F. higher than the average temperature. Continuous ventilation causes excessive wilting. In addition, the temperature of the outside air fluctuates widely, and is often such that ventilation serves only to warm the potatoes. By forced ventilation with cold night air it has proved possible to maintain a stack of potatoes at an average temperature fluctuating within approximately ±2 deg. F. about an average rather below the average weekly air temperature. In answer to a question, Mr. Burton stated that potatoes harvested immature will at first produce more heat than mature ones; but after storage for some weeks the heat production of immature and mature potatoes is approximately the same.

Dr. A. R. Wilson, of the Agricultural Research Council Potato Storage Unit at Sutton Bonington, described the practical advantages to be derived from the indoor storage of potatoes. He stated that a single-story building in which the potatoes are stored to a depth not exceeding twelve feet is most useful under British conditions. The potatoes should be stored in one large mass, not sub-divided into bins. Sub-division by straw bales can be used if necessary to avoid mixing varieties. Storage to a depth of about six feet in existing farm buildings is satisfactorily practised in many parts of the country, and although this method is wasteful of floor space, this

need not be a disadvantage if the space is required for other purposes, such as machinery storage during the summer. Excluding such alternative uses, there is no doubt that storage to a depth of twelve feet is cheaper per ton than is shallow storage. The store should not be less than twenty-four feet wide if machinery is to be manœuvred without difficulty, nor more than thirty feet wide because of difficulties in air distribution if deep storage with bottom ventilation is practised. For storage until March sufficient insulation is provided if the walls have a transmittance value of 0·2 B.Th.U./sq. ft. hr. deg. F. difference, and, if with such walls the roof is insulated to give a transmittance value of 0·15, condensation and drip are prevented. The most efficient means of ventilation is by a thermostatically controlled power-driven fan delivering to ducts under the potatoes. Manual control usually results in less cooling and more ventilation, which latter is to be avoided because of the wilting caused. Bulk harvesting has proved more efficient than other methods, and an elevator-loader has been designed to handle potatoes in bulk. It has a hopper to receive bulk loads from standard tipping trailers and has an outreach of twelve feet when loading to a height of twelve feet. A loading-rate of twelve tons per hour has been reached over short periods, and the turn-round of vehicles with two-ton loads has been achieved in less than seven minutes. Preliminary studies on the comparative costs of clamping and indoor storage indicate that a capital expenditure of £5 per ton on storage accommodation is justifiable, even leaving out of consideration such important advantages of indoor storage as independence of weather conditions during grading. In reply to a question Dr. Wilson stated that the ventilating unit of a grain dryer can probably be used to ventilate a potato store, and, in fact, some farmers are experimenting with such dual-purpose installations using the platform-type sack dryer.

If food is produced far in excess of the need for it, its storage or wastage is a matter of indifference. At the other extreme we may have conditions such that the conservation of farm products to the greatest possible extent is an overriding necessity. For each product mentioned during the discussion, methods of storage are known which will preserve a very high proportion of the value for much longer than is normally necessary; but such methods are regarded as uneconomic under present conditions. It was clear from the discussion that the methods adopted and being sought in practice are therefore compromise attempts to preserve as much as possible within the framework of the present relative values of farm products and the apparatus necessary to preserve them.

LIMITS TO INTENSIVE PRODUCTION IN ANIMALS

ON August 14 at the Edinburgh meeting of the British Association, Section M (Agriculture) held a symposium on "Limits to Intensive Production in Animals". Prof. R. A. Fisher, Balfour professor of genetics, University of Cambridge, read the first paper, taking for his subject "Genetical Limits to Intensive Production in Animals". He referred to farm animals as part of a farmer's machinery for turning material from a less valuable into more valuable form, and said that in the designing of such material the geneticist can make an important contribution. He commented on the separation of genetics and biometry as university subjects dealt with in different departments and taught to different sets of students, thus creating a difference of outlook and preventing progress: he felt that because of this unnatural separation it would be difficult in the future to find personnel with the necessary outlook, although they may be well trained in one or other of the subjects. Prof. Fisher's view is that the work on the breeding of farm animals is so technical and the precision of the biometrical determinations involved are so important that it is necessary to set up biometrical laboratories for the purpose. The genetics of farm livestock have been neglected in the development of the general subject of genetics. This Prof. Fisher attributed to several causes: the two World Wars have shaken the national economy of Great Britain, and there is also to be considered the economic revolution, which has interfered to some extent with the prospects of the older methods employed for livestock improvement. Livestock breeding is slow and expensive, and therefore has not been given its rightful place in research work; in fact, the whole subject of genetics has been left to amateurs and teachers and, therefore, it is but natural that such workers should prefer mice or birds for their work, rather than farm animals. He remarked on the work during the past forty years on *Drosophila* and claimed that these studies have done more towards an understanding of genetic improvement in livestock than have all the efforts made up to date with livestock themselves. He agreed that some beginnings have now been made on serious research work; but he wondered if public officials really think or imagine that a centre for the study of pure genetics of each of the larger species of animals could be of any importance for livestock improvement. Prof. Fisher's final remarks were: "As a last optimistic consideration, let me point out that land long fallowed is sometimes very productive; that unworked gold mines are the best gold mines. Because nothing effectual has been done, we may at least feel sure that the law of diminishing returns has not yet set in, as seems to be the case in some fields of plant improvement, and the ceiling of genetic potentiality is still a long way off."

In the discussion on Prof. Fisher's paper, Dr. H. P. Donald, of the Animal Breeding and Genetics Research Organization of the Agricultural Research Council, directed attention to the recent establishment of the Organization, the object of which is to study the genetics of livestock. The work is long-term, and results will not be available for some time to come. Dr. Donald pointed out that little publicity has been given to the setting up of this Organization, and it may be that this is the best procedure because it will be a long time before any results will be produced for application to the industry.

Further discussion centred around the efforts of practical farmers for livestock improvement, and it was claimed that, by the use of sires selected for specific qualities, improvements have been obtained in some breeds of cattle.

Dr. John Hammond, University of Cambridge, who spoke on "Physiological Limits to Intensive Production in Animals", referred to the British Friesian cow which recently attained a new world record in milk production, yielding in its lifetime nearly 120 tons of milk. He also referred to other high milk-yielding cows as illustrating that the limits of production have not yet been reached; in fact, he considered that there are no physiological limits to

intensive production, provided that suitable nutrition and other environmental conditions are applied. Dr. Hammond showed by diagrams how a system of priorities operates whereby nutrition is supplied from the blood stream for the various body tissues and how the animal adjusts itself to the nutritional requirements. A balance is obtained according to the needs of the different tissues and the extent to which they are developed in the make-up of the animal; in cows in which high milk yields are being developed, the requirements for udder development are greater than those in the poorer milk yielders. He also dealt with pigs, in which he showed that, after feeding at a high nutritional level, better growth and development results if the high level is maintained.

Sir Thomas Dalling, chief veterinary officer, Ministry of Agriculture and Fisheries, took as his subject "Relationship of Animal Health to Production". He pointed out that in the absence of a healthy animal the results of attempted improvement in production may fail. He pleaded for a better understanding of the physiology of some of the important systems in the animal body, the study of which has been long neglected but is now being taken up largely through the efforts of the Agricultural Research Council. Infectious diseases must always limit increased production, and therefore a better understanding of their nature and how they spread is necessary; much attention has been given to their control throughout the world, and measures are being successfully practised. Sir Thomas referred at some length to bovine tuberculosis and the limits its presence in cattle places upon production. Research work has resulted in the application of schemes for its control, and eradication from Great Britain is now being undertaken. Venereally transmitted diseases and the value of artificial insemination in their control were also referred to. Dealing with increased yields of milk, special attention must be given to the health of the udder and the prevention of mastitis. In addition to the knowledge that certain micro-organisms play a part in the causation of mastitis, Sir Thomas referred to the necessity for adopting satisfactory husbandry and hygiene procedures to prevent injury to the udder tissues. He mentioned the necessity for regard for the health of an animal from the time it is conceived and throughout its young life; he stressed the importance of feeding colostrum to the newly-born animal. His remarks also covered the health of pigs and the need for close attention to nutrition whereby a sudden change in the bacterial flora of the digestive tract may be prevented. He gave as an example the finding of large numbers of micro-organisms of the salmonella group in the intestine, following the use of unsuitable diets. Sheep and poultry were also dealt with—the susceptibility of the former to infections with anaerobic micro-organisms, especially when in a thriving condition, and the high incidence of disease in the latter associated with high egg production.

Dr. A. S. Parkes, National Institute for Medical Research, discussed the "Preservation of Spermatozoa at Low Temperature". He showed a film which illustrated the freezing and thawing of red blood cells and spermatozoa in the presence of 15 per cent glycerol, the thawed cells being unimpaired. In the absence of glycerol the spermatozoa do not resume motility. Fowl spermatozoa so treated have been shown to retain their fertilizing capacity. Dr. Parkes thought that, with further refinements of technique, it would be only a matter of time before semen from bulls and other animals could be kept in a frozen condition and used long after it was obtained from the animal: in fact, he foresaw that an animal would be used as a sire long after its death. The results of this work have an important practical application. In artificial insemination as a method of breeding there is a heavy loss of semen, for it is not always possible to adjust supply to demand. When Dr. Parkes and his colleagues have progressed further in their studies, it is to be hoped that they will be able to show that semen from livestock can be preserved with results similar to those they have obtained in poultry; this will be an important forward step in improving livestock production by the greater use of selected sires.

ADVISORY COUNCIL FOR SCIENTIFIC POLICY

THE fourth annual report of the Advisory Council on Scientific Policy* covers the period April 1950–March 1951 and, apart from the discussion of the implications of the Colombo Plan for the employment of scientific workers, technologists and other experts from Great Britain and of the recommendations of the Committee on Toxic Substances in Consumer Goods, which occupy the greater part of the report, covers much the same ground as the third report. In regard to scientific man-power the report notes that the rearmament programme will make particularly heavy demands for physicists, chemists and engineers. The Advisory Council admits that the views expressed in its last report regarding the supply of scientific men under-estimate the difficulty and that over a wide field the demand exceeds the available supply. It has set up a standing Committee on Scientific Man-power, on which the Ministry of Labour and National Service and the University Grants Committee are represented, to deal with the position. The membership of this and of other standing committees set up by the Advisory Council is detailed in an appendix. A particular question of scientific man-power, that relating to biologists, has been remitted to another of these committees, that on Biology and Allied Sciences, and this committee reported that while more general botanists and zoologists than can find employment as such may be graduating, there is a continuing shortage of most kinds of biological specialists, particularly of those suitable for employment by the Agricultural and Medical Research Councils and for posts overseas. It is unlikely that this shortage will be made good for several years, and it may be accentuated if the plans for economic development of under-developed areas, whether under the Colombo Plan or in other parts of the world, come to fruition and the biological work of the Colonial Service increases.

The Advisory Council recognizes the great scope for expansion of Colonial research, and that such expansion is likely to be limited by a shortage of scientific workers trained in the necessary disciplines as well as by financial stringency. It is equally concerned that the demands which the numerous agencies concerned with the development of backward areas may make upon British resources of scientific man-power cannot be met, if all the plans discussed come to fruition, without serious damage to other

* Fourth Annual Report of the Advisory Council on Scientific Policy (1950–1951). Pp. 18. (London: H.M. Stationery Office, 1951.) 9*d*. net.

commitments. It emphasizes that the situation will only become more difficult if suitable undergraduates are now deterred from taking up careers in one of those fields of biology in which there continues to be an unsatisfied demand. It suggests that, where requests for scientific assistance under the Colombo Plan are referred to the United Kingdom, they should be examined, where appropriate, by the Research Councils, to see whether they could be fitted into their current programme of work, and that the men sent abroad should retain a connexion with one of the research councils or some other research organization at home so as to prevent isolation impairing the value of their work. Moreover, although facilities for training in British universities and other institutions are severely taxed and the financial provision may be curtailed, the Advisory Council thinks it important that places should be found for people sent to Great Britain under the Colombo Plan. In this way we could play an important part in the development of South and South-East Asia, and the effect of such assistance would be to cement and strengthen the relations already existing between the United Kingdom and the under-developed countries.

The Advisory Council's discussions on the Colombo Plan brought out three further points which are relevant to any major schemes of development in under-developed territories. First, experience has shown the value of initiating pilot schemes in the first instance, rather than full-scale work. Second, it emphasizes the importance of a historical study of the sociological and ecological effects of similar economic developments in the past, and of attempting to apply sound sociological principles simultaneously with promoting economic development. Third, although the extensive application of science could greatly improve the economic standards of these countries, so long as the population of the world continues to increase at its present rate the hoped-for improvements in the standards of life may not, in fact, occur.

On higher technological education, the present report adds very little to what was contained in last year's report. It notes that the proposal in the report of the National Advisory Council on Education for Industry and Commerce for a "Royal College of Technologists" does not meet the need for an expansion of the facilities for higher technological education. The Advisory Council reiterates the view that expansion of these facilities is essential if we are to develop a balanced supply of applied scientists of adequate calibre and training to achieve the broader and more vigorous applications of scientific methods and advances upon which our industrial prosperity so closely depends. While it rightly points out that the necessary development of technological education is a long-term process which must take more than a decade to achieve, something more might well have been expected of the Advisory Council in this important matter than a hope that an early decision will be announced.

The Advisory Council has received from its Scientific Library and Technical Information Committee a report on the needs of the national library of science and invention which is to form part of the new Science Centre in London. It is understood that the President of the Board of Trade has agreed that the Patent Office Library should be expanded to form the national reference library of science and invention, and that it will continue to serve the needs of the Patent Office. The library will cover the whole field of science and will be supported by the specialized libraries of the learned societies. The areas of its responsibility have been agreed with the Agricultural and Medical Research Councils and with the government departments principally concerned. A novel feature of the library is that it is not proposed that it should contain any scientific literature more than about fifty years old. In conformity with this plan, material which has ceased to have value for current work will be pruned in consultation with the British Museum. The library will serve working scientific men in industry and all those concerned with research and development; but it will not provide for other users, such as undergraduate students, for whom other facilities exist. The Committee's report has been approved by the Lord President of the Council and it has been passed to the Ministry of Works for preliminary planning in connexion with the Science Centre.

The Panel on Technical Information Services has now been dissolved and its responsibilities have passed to the Scientific Library and Technical Information Committee, which is now examining the recommendations in the Panel's report on technical information services in the United Kingdom. This report has since been published in the *Journal of Documentation* (June 1951).

The Advisory Council has considered the comments of the Medical Research Council and of the government departments concerned on the recommendations of the Committee on Toxic Substances in Consumer Goods. While it believes that the risk to life and health is probably small, the rapid growth of the chemical industry and needs of the food-processing industries for substitutes to replace scarce materials or for new chemicals for improving the appearance, palatability or texture of manufactured foods are accelerating the pace at which new chemical substances are being introduced into consumer products, and existing machinery for testing the possible harmful effects of these substances is inadequate. Adequate and fully effective arrangements should therefore be made by government departments for the acquisition of information about possibly noxious substances or processes which industry may contemplate using, before these are allowed to find their way into the composition or treatment of the articles concerned; but the Advisory Council agrees with the view that new legislation is not required at present, and recommends that manufacturers should be informed that they are expected to take all reasonable care to ensure that no new substances should be offered for sale if toxic effects are suspected. It also recommends the establishment of a standing committee of representatives of the departments mainly concerned, and that the Medical Research Council should retain the general responsibility of keeping the whole problem under review and of initiating research and should receive adequate financial provision for the purpose, including the development of information services. Information over the whole field of toxic substances should be interchanged with the appropriate authorities in other countries, and particularly with the Food and Drug Administration and other government agencies in the United States. The Advisory Council also thinks that it would be appropriate for the cost of a central toxicological laboratory to be borne by industry, either through subscriptions or out of fees paid by trade associations.

A Committee on Atomic Energy considered the possible industrial uses of atomic energy and their

economic value. In the view of this Committee, there is a reasonable prospect that atomic power can be developed on a large scale and that the cost would not ultimately differ widely from that of coal. Successful development of an experimental atomic power plant depends largely on metallurgical development which is now proceeding, and the capital cost of an early type of atomic power station would be substantially greater than that of a coal station, although its fuel costs might be less. Development of such stations to a point when they can contribute substantially to the power resources of the country is likely to take at least a generation, and the Advisory Council emphasizes that work on the civil applications of atomic energy should not be allowed to retard inquiries into the better utilization of existing sources of heat and power.

BIOPHYSICAL STUDIES OF RHEUMATOID CONNECTIVE TISSUE

By Dr. J. H. KELLGREN and Dr. J. BALL
Rheumatism Research Centre, The Royal Infirmary, Manchester
AND
Prof. W. T. ASTBURY, F.R.S., Dr. R. REED and E. BEIGHTON
Department of Biomolecular Structure, University of Leeds

Introductory

In rheumatoid arthritis and related syndromes, characteristic changes may be found in the connective tissue for which the term 'fibrinoid' is usually employed. This fibrinoid change occurs in minute spots scattered sparsely throughout the affected tissues; but on the elbows and elsewhere, sizeable aggregates may form which with their surrounding zones of fibrous and inflammatory tissue constitute the classical rheumatoid subcutaneous nodules.

Fibrinoid areas can often be seen with the naked eye as yellowish opaque spots in the semi-translucent connective tissue; but they can be recognized with certainty only by histological examination, when they are distinguished by the following characteristics.

Within a fibrinoid area connective tissue cells are either few or absent altogether, and the regular fibre pattern of normal connective tissue is replaced by a disorderly mesh of swollen, indistinct bundles or clumps of amorphous material. With eosin the fibrinoid area stains a more intense red than the surrounding connective tissue. Deposits of fibrin in the tissues may give rise to a somewhat similar appearance, hence the term 'fibrinoid'.

In frozen sections stained by Lillie's reticulin method and Van Gieson's stain, a fibrinoid area may show three different effects: fine silver-staining fibrils which histologists call reticulin; occasional clumps of material staining reddish-brown like normal collagen; and an indistinct refractile material which takes a yellow colour with the Van Gieson stain. In sections treated by the periodic acid – Schiff technique, the fibrinoid areas stain more strongly than normal connective tissue with the pink or magenta colour which is considered by many histologists to indicate the presence of polysaccharides. Histological evidence, therefore, suggests that a fibrinoid focus is not necessarily homogeneous but corresponds to alterations in both the collagen and polysaccharides of connective tissue.

It would be a substantial advance if these histological appearances could be correlated directly with observations at or near the molecular level, and the purpose of this communication is to present a preliminary account of such a comparison with the findings of X-ray diffraction and electron microscopy.

Methods

Owing to the random distribution and minute size of most fibrinoid lesions, the first requirement was an accurate sampling technique. To this end we obtained biopsy specimens of recently formed subcutaneous nodules from patients with active rheumatoid arthritis, and each specimen was fixed in 5 per cent formol saline and trimmed to a firm rectangular block which was then embedded in ice and cut in such a way that 10 μ–15 μ sections immediately preceded and followed a slice 1 mm. thick. The sections preceding and following the slice were stained in various ways and examined under the optical microscope, and, if they showed suitable areas of histologically well-defined fibrinoid, photomicrographs ($\times$ 8) were made. The corresponding thick slice was then washed in water and enclosed (wet) in a carrier specially adapted to the needs of a point-by-point

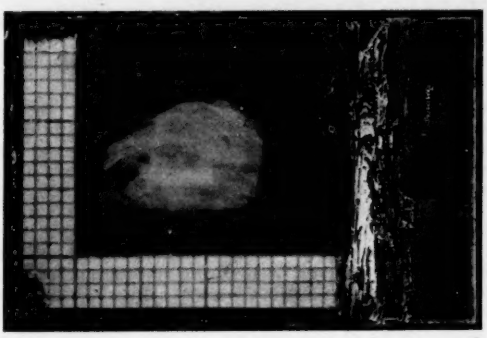


Fig. 1*a*. Slice of rheumatoid subcutaneous nodule mounted in carrier for exploration by X-ray diffraction

Fig. 1*b*. Photomicrograph of immediately adjacent section showing topographical relation between histological and X-ray examination. *N*, probably normal collagen; *I*, incipient abnormality; *X*, fibrinoid sites common to slice and adjacent sections. ●, sites of X-ray photographs

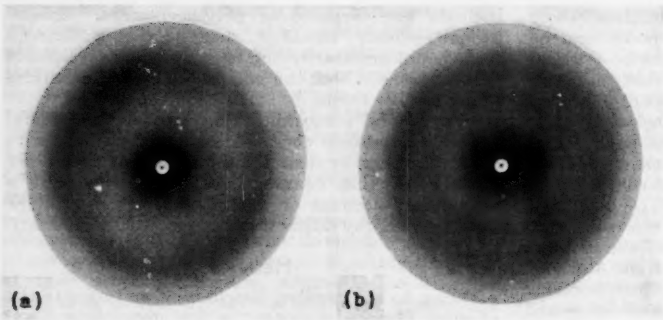


Fig. 2. X-ray diagrams of (*a*) a normal site, (*b*) a fibrinoid site in a rheumatoid subcutaneous nodule

Fig. 3. Electron micrographs of (*a*) a normal site, (*b*) a fibrinoid site in a rheumatoid subcutaneous nodule. × 9,050

exploration by X-rays: it had collodion windows, and it was graduated vertically and horizontally in millimetres, so that when fitted into slides on the spectrometer the co-ordinates of the X-ray beam with respect to the slice could be read off directly for every photograph taken.

For the purpose of relating the X-ray co-ordinates to the topography of the adjacent fore-and-aft histological sections, a negative photographic plate was made of the slice in its carrier (Fig. 1*a*), and this was projected on to enlarged prints of the photomicrographs of the sections. When the best superposition of the two images had been obtained, the co-ordinates inscribed on the carrier were marked also on the prints (Fig. 1*b*).

The slice was explored with an X-ray beam ½ mm. in diameter, photographs being taken of up to as many as thirty different spots. After the X-ray study was complete, tiny fragments were dissected out from each of the same spots and examined in the electron microscope.

Results

Detailed findings will be published at a more advanced stage of the investigation, which is being planned to include an inquiry into whether there is any detectable change in the pathological collagenous tissues corresponding to the dramatic alleviation of symptoms brought about by treatments with adrenocorticotropic hormone (ACTH) and cortisone. It will suffice here to state that the sampling technique just described has proved very satisfactory indeed, and that we have found excellent correlation between the indications of histology, X-ray diffraction and electron microscopy. We have obtained two limiting X-ray diagrams: one (Fig. 2*a*) of normal collagen (often oriented and with, of course, the liquid halo in addition), corresponding to regions which histology also would specify as normal; and the other (Fig. 2*b*) consisting of little more than a diffuse ring of spacing about 4·8 A. This latter diagram we definitely associate with the histological fibrinoid regions—a poor name, by the way, since there is no recognizable X-ray evidence so far of the presence of true fibrin, for which we should expect either an α- or a β-diagram. For many of the spots examined the X-ray photographs showed both diagrams present at the same time, in general one or the other predominating in correspondence with the histological indications. In one region of a slice we found that it sufficed for the X-ray beam to be moved through only ½ mm. for the normal collagen diagram to disappear entirely and be replaced by the pure fibrinoid diagram.

The electron micrographs also revealed two limiting conditions: one of apparently normal collagen fibrils (Fig. 3*a*), and the other of amorphous material. Mostly, however, there was seen a mixture of the two, though again, in general, one or the other predominated in correspondence with the histological and X-ray indications. Fig. 3*b* is a typical picture of an intermediate state.

Concurrently with this special investigation on rheumatoid arthritis, we at Leeds have been collaborating with Prof. R. E. Tunbridge and other colleagues at the Medical School in a wider survey of pathological collagenous and related tissues. From this work it is clear that the real problem in the end is to characterize the degenerate fibrils and amorphous materials that are found so frequently in all sorts of clinically different conditions. Though they look so alike in the electron microscope, they can scarcely be the same every time, and the next step must obviously include comparative chemical analyses. We have already made a beginning along such lines in the rheumatoid arthritis problem, and we hope soon to be able to supplement our correlated histological, X-ray and electron microscope findings on slices of subcutaneous nodules with a corresponding set of micro-biochemical results.

We should like to thank Mr. G. Eaves for assistance in the electron microscopy and Mr. A. Millard for the photographic reproductions.

OBITUARIES

Prof. W. E. Agar, C.B.E., F.R.S.

Wilfred Eade Agar, emeritus professor of zoology in the University of Melbourne, died on August 14, aged sixty-nine. His health had been precarious through cardiac trouble since 1943, and he had to lead a more and more sedentary life; but he continued to work quietly in his little home laboratory up to the day before he died.

Born on April 27, 1882, at Wimbledon, Agar passed from his preparatory school to Sedbergh and then to King's College, Cambridge, where his tutor was S. F. Harmer. He went through the regular courses of instruction for the Natural Sciences Tripos, Parts I and II, in both of which he obtained a first class. Of all his teachers he looked back with special gratitude to Harmer, for his inculcation of precise and orderly method, and to Bateson, then in the flood tide of Mendelism, for turning his mind in the direction of his future research in genetics.

I had been impressed by Agar as the most outstanding member of the Tripos class in zoology during my last year as demonstrator; so when he had completed his Tripos, I invited him to join the staff of the Zoology Department in the University of Glasgow, on which he remained until 1920, holding latterly the position of senior lecturer.

During his Glasgow years, Agar showed himself to be an admirable teacher, and he also achieved a large proportion of his most valuable research work. During his first two years this was devoted to vertebrate morphology, and he produced valuable papers upon the skull and visceral arches, and upon the anterior mesoderm, of *Lepidosiren* and *Protopterus*. In 1907 he made an expedition to the Gran Chaco to supplement my work on *Lepidosiren*; but above all to obtain full material for investigating the gametogenesis of that fish—outstandingly suitable for such a research on account of the relatively enormous size of the chromosomes and their strongly marked individuality. Agar made a splendid success of his expedition and brought back a large amount of perfectly preserved material which he proceeded to investigate in detail. His skill and accuracy as an observer, in conjunction with his admirable technique, enabled him to achieve what is still probably the most reliable account of the gametogenesis of a male vertebrate. In his work he made full use of the Glasgow technique, which enjoined that all microscopic work under high-power oil-immersion objectives be done with stereoscopic eyepieces—the technique which enabled Ballantyne in 1925 to establish with certainty the passage of neurofibrils across the generally accepted discontinuity between the neurones of the vertebrate nervous system. Agar's Chaco expedition achieved other results than those of his main quest, the most important being the discovery of the 'neonychium'—the cushion-like structure which in the embryo of the Amniota fills up the concavity of the claw and safeguards the amniotic membranes against injury.

Agar's work on the chromosomes of *Lepidosiren* may be said to inaugurate the second phase of his research career, devoted to genetics. Next after it came the breeding through long series of generations of Daphnid crustaceans and having as their main object the testing of Lamarckian inheritance of environmental or 'acquired' characters. The Daphnids in question were chosen as specially advantageous for such investigations in view of their parthenogenetic reproduction, their short life-cycle, and the fact that all members of a clone are genetically identical so as to exclude the disturbing effects of Mendelian segregation. The results of Agar's work on the whole, including one particularly precise set of experiments extending over a hundred generations, was to show the complete absence of any evidence of such inheritance.

Both by his own original work and by his critical examination, and in some cases repetition, of the work of others, Agar played an important part in substantiating the view that environmental or 'acquired' characters are not inherited and are therefore not available for the process of racial evolution.

In its third phase, Agar's work diverged from the realm of pure science, in which things are observed, accurately recorded and when possible seriated into a general expression, into the realm of 'philosophy', which deals rather with ideas or opinions, and is free from the constraints to which purely scientific research is subject. In this phase Agar was, above all, influenced by the philosophy of A. N. Whitehead—primarily a mathematician, not a biologist—as expounded in his "Process and Reality". According to this philosophy, reality consists not in substance but in process, and the difference between living and non-living 'organisms' is merely one of degree—"Biology is the study of the larger organisms; whereas physics is the study of the smaller organisms." Whether or not Whitehead's philosophy is destined to have any influence upon the advancement of biological science, it is clearly of advantage to have an account of it and its implications from the pen of one who not only accepts the general principles of that philosophy but also holds a distinguished position in the realm of biological science. Such an account with further developments in detail is provided by Agar in his last book, "A Contribution to the Theory of the Living Organism" (Melbourne University Press, 1943), a revised edition of which he had just completed at the time of his death.

It would be wrong to conclude this notice without mention of Agar's activities outside laboratory and lecture-room. At Glasgow he held a commission in the Officers' Training Corps, and during the First World War he was captain in the 5th Highland Light Infantry, until invalided home from Gallipoli. Later he acted as adjutant to the 1st Volunteer Battalion of the same regiment. Then in 1920 came his appointment to the professorship of zoology at Melbourne. There he served as dean of the Faculty of Science (twice), president of the Professorial Board, in which he played an important part in the deliberations preceding the appointment of a full-time vice-chancellor, and as member of the University Council (twice).

As a Melbourne colleague writes, "Wilfred Eade Agar will be remembered by all as a thoughtful and kindly man, reserved, yet with a delightful sense of humour, slow to assert himself, yet vehement when the need arose. With his death the University of Melbourne has lost one of its great men."

JOHN GRAHAM KERR

Brigadier E. M. Jack, C.B., C.M.G.

BRIGADIER EVAN MACLEAN JACK, who died on August 10, was born in Edinburgh in 1873. Commissioned in the Royal Engineers in 1893, he served first at Gibraltar and St. Helena; and in 1903 joined the Ordnance Survey, on the staff of which he served for four years.

In 1907 he was selected for duty with the Uganda–Congo Boundary Commission under Major Bright and four years later became chief commissioner of another Central African Boundary Commission, which, in the course of its work, measured a section of the arc of the 30th meridian. In 1913, Jack, now promoted major, was posted to the Geographical Section of the General Staff at the War Office; and on the

outbreak of war, in 1914, went to France with the B.E.F. as officer in charge of maps at G.H.Q. In this post, which he held throughout the War, he was responsible for directing and controlling a great variety of survey developments, including the mapping of the trench lines, German as well as British; sound-ranging and flash-spotting (for the location of enemy batteries); and, last but far from least, the 'Artillery survey' procedure, which made possible the sudden accurate bombardments of 1918 by massed artillery—a development which, from the battle of Cambrai onwards, contributed so much to the Allied victory.

For his services in the First World War Jack was awarded the C.M.G. and the D.S.O. and was several times mentioned in dispatches. The Royal Geographical Society, which in 1916 had given him its Gill Memorial Award for his work in Africa, awarded him its Founder's Medal for his geographical work on the Western Front. In 1920 he became head of the Geographical Section, and two years later succeeded Sir Charles Close as director-general of the Ordnance Survey. In 1924 he was promoted to the rank of brigadier, and in 1928 was made a C.B.

Jack retired from the Service in 1930, but this 'official' retirement was only the beginning of another career of unpaid service to many charitable and other causes, scarcely less distinguished than the one he had just completed, and which lasted for twenty years more. The kindliest and most modest of men, Brigadier Jack has left a record which any man might envy; and a memory which all his many friends will cherish.

M. N. MacLeod

Prof. E. Baldi

Prof. Edgardo Baldi died on August 10 at the age of fifty-two very much regretted by all his friends and colleagues. He was director of the Istituto Italiano di Idrobiologia at Pallanza on the Lago Maggiore, a research institute founded in 1939 which has become one of the world's leading limnological laboratories.

Baldi's research career began with work on insect neurophysiology which has left important traces in the literature. He soon turned, however, to hydrobiology, beginning with systematic work, especially on diaptomid copepods. He made a study of the distribution of the various races of *Eudiaptomus vulgaris* in Italian lakes. One of his favourite fields of research was the biology of alpine lakes, the chief object of which was to define the communities and discover their degree of temporal constancy. Rivers were also studied, the main thread of the research being the seasonal variation and survival in rivers of plankton derived from lakes.

In the last period of his life, Baldi's particular interest was in the biometrical study of form differences between planktonic Crustacea of certain species belonging to populations of varying density living in different parts of a lake. General accounts of this important part of his work are to be found in *Experientia*, **2**, 476 (1946) and *Vierteljahrschrift Naturf. Ges. Zürich*, **95**, 89 (1950), while details are in the *Memorie Ist. Ital. Idrobiol.* His was always the spirit of pure scientific research for its own sake. To British and other foreign biologists who had the pleasure of visiting or working in his Institute, Baldi always extended a most generous welcome.

H. Munro Fox

Dr. G. A. Shakespear

Dr. Gilbert Arden Shakespear, who died as a result of a road accident within a few days of his seventy-eighth birthday, was a prominent member of the University of Birmingham for more than half a century. Educated at Wyggeston School, Leicester, and Mason College, Birmingham, he was one of J. J. Thomson's research students at Cambridge before returning to Birmingham as lecturer under Poynting. He was acting professor during 1914–19 and, though he retired in 1938, he continued active research work in the Department of Physics.

Dr. Shakespear was distinguished for his ingenuity and skill in making precise measurements by simple methods. Much of his early work was inspired by Poynting, whom he greatly admired, and was concerned with thermal radiation. His most important contribution to science, however, arose from a practical need and was made with characteristic speed and perfection. During the First World War his attention was directed to the need for measuring the purity of hydrogen in connexion with airships and observation balloons; he quickly produced his 'katharometer', a sensitive and robust apparatus for gas analysis by thermal conductivity, and then applied it in many different directions, the principal one at that time being the permeability of rubberized fabrics.

Although the instrument has now been extensively used in measuring mixtures of many gases and in all kinds of applications, it still remains in the essentially simple form which Shakespear originally devised. The katharometer, in the hands of many workers, has been the means of making substantial contributions to many branches of science—physics, biology, physiology, medicine and chemical engineering. It is ideally suitable for measuring diffusion and thermal diffusion: it is used for measuring the respiration of plants and animals, for the control of anæsthetic gas mixtures, for the analysis of flue gases and the exhaust gases from internal combustion engines, and in ammonia plants. An indication of Shakespear's ingenuity and breadth of interest is given by the fact that with only a slight modification he was able to convert the katharometer into a very sensitive extensometer.

Shakespear was always most generous in freely giving his ideas to others. He delighted in having problems brought to him and in assisting in their solution. For this he wanted no recognition or reward; his pleasure lay in sharing in the enthusiasm for any subject and in sowing the seed of progress. His influence has thus been much greater than can be measured by the volume of his published work.

In his teaching, Shakespear was remarkable for his originality and freshness of approach on the experimental side of his subject. A student's measurement of the acceleration due to gravity in the elementary laboratory was to him a matter of importance and excitement, in which the result really mattered.

Shakespear was a man of extraordinary activity, both mental and physical, and an uncommonly keen observer of everything that lives and moves, as well as of the inanimate things. His wife, the late Dame Ethel Shakespear, was a geologist and a notable figure in the public life of the Midlands. Their farm, garden and laboratory at Caldwell Hall, near Bromsgrove, formed an ideal centre for a rare breadth of interests.

NEWS and VIEWS

Botany at Birmingham: Prof. W. Stiles, F.R.S.

Prof. W. Stiles has retired from the Mason professorship of botany in the University of Birmingham, which he has held since 1929. He moved to Birmingham after occupying the chair of botany at Reading for ten years. He has brought renown to his Department, both by his own published papers, reviews and books, and by the direction or stimulation given to the physiological researches of his colleagues and students, especially in the fields of permeability, the salt relations of plant tissues, and respiration. The way was prepared in the first field by early work done in the University of Leeds, where he collaborated, first with Mr. I. Jørgensen and, later, with Dr. Franklin Kidd. They developed the method of placing representative samples of disks of storage tissue under selected and controlled conditions. This technique for obtaining reproducible results is now widely used in many types of investigation.

Throughout his career, Prof. Stiles has favoured the use of physical instruments for measuring plant performance. In more recent times, skilled work has been performed in his research school with the katharometer in studies on respiration, and with the spectrograph, polarograph and absorptiometer in measuring small amounts of ionic absorption. Exact quantitative data have been obtained for physiological performances, controlled in the light of existing knowledge. Certain passages in his presidential address delivered in 1938 to Section K (Botany) of the British Association make it clear that no one knows better than Prof. Stiles that this knowledge is incomplete. However, he has helped to make it more ample than it was forty years ago. Moreover, no one in Great Britain has ever done more in bringing together scattered literature and making widely known major advances in knowledge of plant physiology as these occurred. We may note his review articles which have appeared regularly in *Science Progress* since 1927, and his books on "Carbon Assimilation" (1917, with I. Jørgensen), "Permeability" (1924), "Photosynthesis" (1925), "Respiration" (1932, with W. Leach), "An Introduction to the Principles of Plant Physiology" (1936, second edition 1950), and "Trace Elements in Plants and Animals" (1946, second edition 1951).

Prof. E. J. Maskell, F.R.S.

Dr. E. J. Maskell, reader in plant physiology in the University of Cambridge and Fellow of Emmanuel College, has been appointed to succeed Prof. W. Stiles in the Mason chair of botany from October 1. After a distinguished academic career at Cambridge, interrupted by service in the Friends' Ambulance Unit, 1915–19, Dr. Maskell, as Frank Smart student, carried out researches under the late Dr. F. F. Blackman on carbon assimilation with particular reference to stomatal control. In 1922, Dr. Maskell was appointed plant physiologist at the Cambridge Horticultural Station. Two years later he moved to Rothamsted Experimental Station in the same capacity, where he worked on problems of crop growth and methods of field experimentation. In 1926 he went to Trinidad as plant physiologist at the Cotton Research Station, where, in association with Dr. T. G. Mason and Dr. E. Phillis, he carried out notable investigations on the transport of carbohydrates and other solutes in the cotton plant. In 1930 he was recalled to Cambridge as lecturer in plant physiology, afterwards becoming reader and head of the sub-department in this subject in the Botany School. Since his return he has taken a prominent part in teaching and research, chiefly on the metabolic aspects of plant physiology, and many students have carried out investigations under his direction. He was elected a Fellow of the Royal Society in 1939. He returned to Trinidad for the summer of 1950 and assisted in the researches proceeding at the Imperial College of Tropical Agriculture on the mineral nutrition of the cocoa plant. Dr. Maskell has had much experience of university and college administration, and served for a considerable period on the General Board of the Faculties. Birmingham is fortunate in securing the services of Dr. Maskell, and he will be greatly missed by his colleagues in the Cambridge Botany School.

Scientific Civil Service: Promotion of Individual Research Workers

It is announced that further special posts are being created for individual research workers of exceptional merit. The promotions will be effective from January 1, 1952.

Deputy Chief Scientific Officers:

Dr. E. Glueckauf

Dr. E. Glueckauf, an outstanding physical chemist who during the pre-war period made notable contributions in surface phenomena, radiochemistry and in the measurement of the constituents of the atmosphere. Since joining the Atomic Energy Research Establishment his researches have included solution chemistry and the study of chromatography and ion exchange.

Mr. N. W. Pirie, F.R.S.

Mr. N. W. Pirie, of Rothamsted Experimental Station, is well known for his work on the separation and biochemical properties of substances of diverse biological origin and high molecular weight. The group includes antigens from *Brucella melitensis* and *B. abortus*, agar, several plant viruses, hyaluronic acid and proteins from the normal leaf. The last has been studied both on the laboratory and on the industrial scale. Most of these substances have been shown to be heterogeneous, and he has emphasized the importance of looking on macromolecules, even when they have a defined biological activity, as categories rather than as chemical individuals.

Dr. H. G. Thornton, F.R.S.

Dr. H. G. Thornton, of Rothamsted Experimental Station, has investigated many aspects of the life of the nodule bacteria and their symbiosis with their host legume, including their behaviour in soil, the process of the root infection, the growth and decay of the nodule and the structure of nodules ineffective in fixing nitrogen. With P. S. Nutman and J. H. Quastel he took part in the early experiments on the selective toxicity to plants of 2,4-dichlorophenoxyacetic acid. He has made quantitative studies of the soil microflora, and in this field he has devised improved counting methods.

Senior Principal Scientific Officers:

Mr. J. E. Gordon

Mr. J. E. Gordon, a research engineer at the Royal Aircraft Establishment, whose work has been directed towards the use of plastic structural materials for

aircraft. This has involved fundamental work on structural plastics and the development of suitable plastic materials and manufacturing techniques. As a result of this work it has been demonstrated that large aircraft structures can be made cheaply and easily from reinforced plastics, and that such structures will compete successfully with the more conventional metal structures.

Dr. C. C. Hall

Dr. C. C. Hall, of the Department of Scientific and Industrial Research (Fuel Research Station), a chemist who has specialized on problems concerned with the production of oils and chemicals from coal, and is a recognized authority on the subject. He has made notable contributions to knowledge of the mechanism of the reactions in the hydrogenation of coals and tars and in the synthesis of hydrocarbon oils and waxes from carbon monoxide and hydrogen. He has played a leading part in the C.I.O.S. investigations of German researches in this field, and of the commercial plants in Germany for the production of oils and chemicals from coal; and he has been in close touch with the work of the U.S. Bureau of Mines on synthetic liquid fuels.

Dr. L. Pincherle

Dr. L. Pincherle, who joined the Telecommunications Research Establishment, Malvern, in 1948, after a distinguished academic career. Since this date he has been engaged in a study of the electronic properties of semiconductors using the methods of quantum mechanics. He has been largely responsible for initiating an extensive calculation of the electronic wave functions in ionic crystals having cubic symmetry, and has been responsible for the development of powerful mathematical methods to enable this to be achieved.

Dr. D. G. Tucker

Dr. D. G. Tucker, of the Royal Naval Scientific Service, who has had wide experience in telecommunications. For many years he was at the Post Office Research Station, Dollis Hill, before joining the Admiralty. His many valuable publications on important electronic problems give some indication of his ability as a research engineer, and the theoretical and practical work he is now doing on underwater problems is of particular concern to the Royal Navy.

Royal Aeronautical Society: Awards

The following medals and prizes have been awarded by the Council of the Royal Aeronautical Society: *Society's Gold Medal:* W. G. A. Perring (posthumously), in recognition of his distinguished service to aeronautical science; *Society's Silver Medal:* S. B. Gates, for outstanding work on the stability and control of aircraft; *Society's Bronze Medal:* H. J. Pollard, for his many contributions to the development of aircraft construction; *British Gold Medal:* A. E. Russell, for practical achievement in aircraft design; *British Silver Medal:* Group Capt. J. Cunningham, for his outstanding achievements as a test pilot; *R. P. Alston Memorial Prize:* R. J. Falk, for his outstanding work in the testing of British delta-wing aircraft; *George Taylor (of Australia) Gold Medal:* R. E. Bishop, for his paper on "Design for Maintenance"; *Simms Gold Medal:* Dr. G. S. Hislop, for his paper on "Investigation of Gusts"; *Herbert Ackroyd Stuart Memorial Prize:* A. V. Cleaver, for his paper on "Rockets and Assisted Take-off"; *Edward Busk Memorial Prize:* R. Hills, for his paper on "The Use of Wind Tunnel Model Data in Aerodynamic Design"; *Orville Wright Prize:* Dr. Neumark, for his paper on swept-back wings, published in the *Aeronautical Quarterly*, August 1950.

National Institute of Sciences of India: Research Fellowships

The National Institute of Sciences of India has recently awarded the following research fellowships (normally tenable for two years) for work in particular fields at the places shown. *National Institute of Sciences Senior Research Fellowships:* Dr. A. M. Naqvi (solar problems), University of Delhi; Dr. S. C. Shome (corrosion of metals), National Metallurgical Laboratory, Jamshedpur; Dr. B. G. L. Swamy (comparative plant morphology), University of Madras. *National Institute of Sciences Junior Research Fellowships:* D. Basu (statistics), Indian Statistical Institute, Calcutta; Dr. M. Datta (statistical physics), University of Calcutta; Dr. A. M. Mehta (biochemistry), Haffkine Institute, Bombay; Dr. A. K. Mukherjee (bacteriology), Indian Institute for Medical Research, Calcutta; Dr. (Mrs.) T. S. Sarojini (mycology), University of Madras; E. G. Silas (zoogeography), University of Madras; T. B. Sinha (entomology), University of Allahabad. *Imperial Chemical Industries (India) Research Fellowships:* Dr. B. K. Banerjee (physical chemistry), Indian Association for the Cultivation of Science, Calcutta; Dr. A. Ganguli (plant pathology), Bose Research Institute, Calcutta; Dr. P. T. Rao (spectroscopy), Andhra University.

Graduateship of the Institute of Physics: A New Grade

A booklet recently issued by the Institute of Physics, and which may be obtained free, on request, sets out the regulations and syllabuses for the examination for the graduateship grade of membership of the Institute. This new grade was formed in September 1949 and is for those who hold a recognized degree or other qualification in physics but who do not possess the necessary period of professional experience required for the associateship of the Institute. By July of this year more than four hundred applicants had been elected to graduateship. At the moment, such applicants are only admitted if they possess an honours degree of a British university; but for those who are without this qualification an examination, starting in 1952, is being arranged. Candidates for this examination will normally be required to have followed a suitable course of study at a college or other place of learning recognized for this purpose by the Institute, those already approved including all the universities and university colleges in Great Britain, a number of Commonwealth and foreign universities, and thirty-six technical colleges in Great Britain. The subjects of the examination are physics (three papers and a practical examination), mathematics (two papers), and a third subject (one paper) chosen from applied physics, more advanced physics, mathematical physics and statistics; those choosing applied physics will be required to offer only one of the sections, electronics, high-vacuum technology, acoustics, spectroscopy, X-rays or temperature measurement. Those who already have certain qualifications may be exempted from various parts of the examination. Graduates of the Institute,

who must have reached the age of twenty-one, are entitled to use the abbreviation Grad.Inst.P. The grade is non-corporate and is intended to be the normal step to associateship of the Institute.

Soil and Climatic Factors in Plant and Animal Nutrition

THE first of the specialist conferences, recommended by the British Commonwealth Scientific Official Conference of 1946, was held in Australia in 1949 to consider "Plant and Animal Nutrition in Relation to Soil and Climatic Factors". A general report of the proceedings appeared in 1950; but the papers presented, together with the recommendations and resolutions passed, have now been published in full (pp. 490. London: H.M. Stationery Office, 1951; 20*s*. net). The various aspects considered cover a wide field, and some idea of their scope may be obtained from the titles of the five sessions held: review of present knowledge of the climatic and soil factors affecting nutrition of plants and animals; effects of specific soil and climatic factors on the nutrition of plants; nutritional problems of the animal as determined by plant and soil; pasture management; and influence of plant and animal on soil fertility. From the papers presented, it is evident that a wealth of information has already been obtained in each field; but in its recommendations the conference stresses the necessity for closer co-ordination of research if full use is to be made of the knowledge acquired and the gaps in that knowledge filled. In particular, the need for co-operation is urged between, on one hand, specialists in soil science, agronomy, plant physiology and biochemistry and, on the other, animal research workers. As a practical outcome of the deliberations, a number of specific lines of work which call for immediate investigation are suggested, together with outlines of the type of experiment which could be usefully conducted on a long-term basis.

Fall in World Malaria

WHEN the effectiveness of DDT against mosquitoes was realized, and particularly when the value of residual films of this insecticide was discovered, hopes were raised that at last a method had been found which would make possible the control of rural malaria at a practicable cost. A recent article by E. J. Pampana (*Bull. Org. Mondiale de la Santé*, 3, 557; 1951), written at the suggestion of the Executive Board of the World Health Organization, summarizes the results of a number of large-scale campaigns in Africa, America, Asia and Europe in which the use of residual insecticides figured prominently. It makes encouraging reading. In treated regions of Brazil, notified cases of malaria fell from 18,297 in 1945 to 976 in 1949; in one typical village in British Guiana, the spleen index fell from 71·6 per cent in 1945 to 4 per cent in 1948; in Ceylon, infant mortality in 1949 was only 62 per cent of what it was in 1946; in Greece, the most malarious country in Europe, where morbidity varied from 1 to 2 millions a year between 1930 and 1940, malaria has now "ceased to constitute a serious public health problem". A conspicuous gap in the reports is left by tropical Africa where, as yet, very little seems to have been done. Two problems loom ahead: a possible breakdown in the method if the mosquito becomes tolerant to the insecticide, and a great upswing in human populations if these measures continue to prosper.

Antihistaminic Agents in Allergy

A VALUABLE publication, "Antihistaminic Agents in Allergy" (*Ann. New York Acad. Sci.*, 50, Art. 9, 1013; 1950; 3 dollars) records the papers given at a conference on this subject held in October 1947. Although about half the papers deal with antihistaminic agents, the remainder deal with histamine itself; and among these a paper by Sir Henry Dale, entitled "The Pharmacology of Histamine", includes a brief survey of evidence for the occurrence of histamine and its liberation and participation in natural reactions. The volume as a whole records the results of a great deal of research, and the bibliographies appended to each paper indicate how extensive the study of histamine and antihistaminic agents has been.

A Royal Head from Ancient Egypt

THE Freer Gallery of Art, which forms part of the Smithsonian Institution, Washington, D.C., possesses an interesting royal Egyptian head, and the late Dr. George Steindorff was asked to describe it. His findings have been published by the Gallery in a little booklet, under the title of "A Royal Head from Ancient Egypt", which runs to thirty pages of text and twenty-nine full-page illustrations and is a commendable little study (Occasional Papers, 1, No. 5; Pub. 4022; 1951). Dr. Steindorff has taken the opportunity not only to make a study of the particular sculpture in question, but also to illustrate for purposes of comparison the various styles in sculpture that appear at different times in Egyptian history. The result is a very useful little brochure for those interested in portrait sculpture who do not happen to be specialists in Egyptian archæology.

Ancient Polynesians as Navigators

AN article by T. G. F. Mann (*Irish Astro. J.*, 1, No. 4; 1950), with the title "The Polynesian, Master Mariner and Astronomer", outlines the extraordinary navigational ability of the early Polynesians in their voyages through the central and eastern Pacific, the islands of which are peopled by a race which displays very remarkable similarities in appearance, character, language and traditions. It appears that they used the stars as compass, chart and chronometer, and the Pleiades and Antares were especially utilized. It is remarkable that they fixed the northern solstice about June 25, and this was determined by the appearance of the Pleiades at about 5 a.m. 22° above the horizon. A description of their method for determining degrees is given and, crude as it may seem, it was sufficiently accurate to enable the navigators to find their directions for thousands of miles across unknown seas. It is believed that the people in the Hawaiian group were able to measure the altitude of Polaris by means of a gourd filled with water. It is very remarkable, as the author points out, that when the Western mariner was largely confined to the Mediterranean, creeping cautiously along its seaboard, the Polynesians regularly covered thousands of miles of open sea.

Properties and Uses of Photoelectric Cells

AN illustrated booklet, "Electric Eyes", by A. J. Fawcett and published by the Tintometer, Ltd., Salisbury, contains an elementary and somewhat entertaining account, suitable for the non-technical reader, of the properties, use, advantages and disadvantages of the photoelectric cell. Part 1 deals

with the use of the photoelectric cell on the underground railways where the interruption of a beam of light by the train sets the signals; as a burglar alarm, a counting or safety device; to grade manufactured articles according as they are light or dark; for smoke detection and to measure the turbidity or pollution in canals and rivers. Part 2 is concerned with colorimetry. It is emphasized that the photoelectric cell is colour-blind and that it is a robot device. "Its failures in the field of colorimetry are not the shortcomings of the photoelectric cell, but of the operator who is making unreasonable demands upon it." The constructions of the photoemissive and the barrier-layer or photovoltaic cells are described in an appendix, the way in which the latter type of cell works being illustrated pictorially by rabbits in a field near their burrows. For the benefit of those on unfamiliar ground, the booklet is completed by a glossary of terms used.

Municipal Library System of London and the Home Counties

The sixth report of a quinquennial series issued by the Library Association (London and Home Counties Branch) summarizes information regarding the rate-supported municipal library system of London and the Home Counties as existing on March 31, 1949 (pp. 32; general editor, James D. Stewart; London: Central Public Library of Hampstead, 1951). The report covers 119 separate library authorities in the counties of London, Bedford, Berkshire, Buckinghamshire, Essex, Hertford, Kent, Middlesex, Surrey and Sussex, and the information analysed includes all grades of the public library service. The development of the library service in the area over a quarter of a century is traced, and the report is essentially factual: conclusions as to the value and tendencies of details of policy are sparingly drawn. Generally, the service of the area reaches twice as many people as in 1924; issues of books are more than four and a quarter times more numerous; its stock of books has increased more than fourfold; and there are nearly five times as many registered readers as in 1924.

Certificates and Diplomas in Management Studies

The British Institute of Management was established in September 1947 and, early in 1949, undertook to administer jointly with the Ministry of Education a national scheme of management studies, the Institute acting as the co-ordinating authority for the various professional bodies concerned. Regulations covering the national scheme agreed to jointly by the Ministry and the British Institute of Management, and the Scottish Education Department and the British Institute of Management, were published in 1949 and 1950 and, since that time, technical colleges have been changing over to the new scheme. The majority of professional management bodies agreed to accept a common intermediate certificate in place of their own examinations, while the professional technical institutions which include management studies in their requirements are prepared to grant certain exemptions. Now it may be said that the intermediate certificate stage has been successfully launched, and the second stage, the preparation of suitable diplomas for various specialized management organizations, is under consideration. To clarify the present position and to collate existing information, the British Institute of Management has prepared a handbook giving full details of the examinations, a list of institutions accepting the common intermediate examination, and the proposals for the development of diplomas in management studies. The handbook may be obtained from the British Institute of Management, Management House, 8 Hill Street, London, W.1, price 6*s*. 3*d*.

Announcements

Dr. C. W. Allen, of the Commonwealth Observatory, Mount Stromlo, Canberra, has been appointed to the Perren chair of astronomy tenable at University College, London, from October 1, or as soon thereafter as possible.

Prof. J. Brontë Gatenby, professor of zoology and comparative anatomy in Trinity College, Dublin, has been appointed visiting professor of zoology in the Faculty of Science, King Farouk University, Alexandria, from October 1.

The Exhibition on the "Human Factor in Industry", at the Safety, Health and Welfare Museum, Horseferry Road, Westminster, London, S.W.1 (admission free; 10 a.m.–6 p.m.), which was to have closed on September 29, will remain open until October 19.

Sir George Beilby Memorial Fund awards, which are considered by administrators representing the Royal Institute of Chemistry, the Society of Chemical Industry and the Institute of Metals, are made at intervals to British scientific research workers, preference being given to investigations relating to the special interests of Sir George Beilby, including problems connected with fuel economy, chemical engineering and metallurgy. In general, the awards are granted to younger men and women for original work done over a period of years. Awards may be made early next year, and the administrators request that their attention be directed to outstanding work of the nature indicated, not later than December 31. All communications should be addressed to the Convener of the Administrators, Sir George Beilby Memorial Fund, Royal Institute of Chemistry, 30 Russell Square, London, W.C.1.

The eighteenth Christmas Chemical Engineering Symposium, arranged by the Division of Industrial and Engineering Chemistry of the American Chemical Society, will be on the subject of "Nucleation" and will be held at Northwestern University, Chicago, during December 27–28. The programme will be divided into the following four sections: theoretical aspects, and nucleation from the gas, liquid and solid phase respectively. Attendance is open to all; but papers must be sponsored by a member of the American Chemical Society. Communications should be addressed to the chairman of the Papers Committee, C. M. Cooper, Engineering Research Laboratory, Du Pont Experimental Station, Wilmington, Del. Local arrangements are in the hands of Dr. L. F. Stutzman, of Northwestern University, Evanston, Chicago, Ill.

Erratum. In the article entitled "The Development of Taxonomic Theory since 1851" by J. S. L. Gilmour in *Nature* of September 8, on p. 402, column 1, a line of type following line 16 has been omitted. The sentence should read: "It can be called phylogenetic only in a secondary sense, namely, that the reason why a particularly natural biological classification can be made at all is the paramount influence of heredity on the characters of living things. . . .".

INTERNATIONAL UNION OF CRYSTALLOGRAPHY

CONGRESS AT STOCKHOLM

THE Second Congress of the International Union of Crystallography, which was held at the University of Stockholm during June 27–July 5, was attended by more than three hundred members from different parts of the world. Although Britain and the United States provided the largest foreign contingents, the diversity of other nationalities was such that the English-speaking people were in the minority; nevertheless, English was used as the main medium of communication, although some papers were given in French and German. Tribute must be paid to those who forsook their native language to speak English, and to others who, having no English, took particular pains to make themselves clear; unfortunately, the speed of delivery of some of the English papers must have made it difficult for them to receive much in return.

As in the first Congress (see *Nature*, 162, 838; 1948) so many papers were presented that it was found necessary to hold simultaneous sessions, this time in triplicate. Thus it was impossible for a single observer to hear all the papers, and the present account must be regarded as representing mainly the particular interests of the writer; it is mainly concerned with X-ray diffraction, and for the section on electron diffraction he is largely indebted to Dr. L. E. Sutton, of Oxford, who kindly allowed access to some of his notes.

Instruments for X-ray diffraction. It is interesting to compare the state of the subject of X-ray diffraction with that existing at the time of the first conference, in 1948. There would seem to have been a period of stabilization, as no discoveries of major importance have arisen; but we can now see much more clearly how some of those made just after the War fit into the general scheme.

For example, consider instruments. In 1948, we were only beginning to see the application of Geiger–Müller counters to single-crystal work, although their use for powder work had been fairly thorough. We can now see extremely important developments. The results are more accurate than those obtained photographically, but only if a great deal of trouble is taken in obtaining them. Consequently, at present, the method would be employed only if extreme accuracy is required, and it is likely that, for most structure investigations, photographic equipment will continue to be used. There is, however, no reason why improvements in instrumentation should not change this state of affairs, and we may find that ultimately photographic methods will be relegated to quite a minor part in structure determination.

Neutron diffraction is also developing rapidly; with the introduction of the neutron spectrometer at Harwell, practical work is no longer confined to America. For obvious reasons, it is unlikely that neutron spectrometers will ever become very numerous, and hence it is important to see that they are used for those problems for which they are particularly suitable. We cannot, therefore, expect that they will make great contributions to orthodox crystal-structure studies, but nevertheless they are opening up a new field of their own. A particularly fascinating subject is that of the antiferromagnetics, in which neutrons are able to differentiate between isotopes of which the magnetic moments are opposed; superlattice effects are found which are quite undetectable by X-rays.

Crystal-structure determination. Methods of crystal-structure determination figured largely in the Congress, and were the subject of a detailed symposium held after the Congress had ended. Many interesting new ideas were described; but none could be considered as likely to revolutionize the subject. They are more likely to simplify the determination of structures of which the unit cells contain relatively few atoms, but of which the chemistry is uncertain; for structures with large numbers of parameters, the well-established methods which make use of isomorphous replacement and heavy atoms still stand supreme.

The new methods attempt to make use of certain general properties that crystals must possess—that is, that they are composed of atoms of known electron densities. The Harker–Kasper inequalities, for example, make use of the fact that electron densities are always positive. Attempts are now being made to make use of the known interatomic distances, and some success has been obtained with the resulting methods on crystals that have one small cell dimension. Attempts to make use of other facts—for example, that the electron density must be zero at a centre of symmetry if all the atoms are in general positions—do not seem to be fruitful.

Considerable help to the application of these methods has been given by the Fourier machine at Pennsylvania State College. This machine, which produces two-dimensional electron-density maps almost instantaneously, was not yet finished in 1948; but reports now show that it fully justifies the claims made for it. Not only is it helpful in greatly speeding up routine work, but it also seems to be inspiring the application of some of the theoretical methods mentioned in the previous paragraph.

The 'steepest descents' method has not proved to be capable of deriving structures *ab initio*, as was hoped on its first introduction, and it now appears to be settling down as a method for the refinement of approximate structures. Other methods, such as 'least squares' and the 'difference synthesis', also exist for this process, and there would seem to have been distinct advances both in the accuracy and the assessment of accuracy of structure determination in the past three years.

Perhaps the greatest advances in crystal-structure determination, however, are taking place in the application of the Patterson synthesis; this method, which is now fifteen years old, still seems to be capable of providing fresh approaches, and closely similar lines are being followed in France, Spain, the United States and Great Britain. It will be interesting to see, at the next Congress, whether these approaches will prove to be as fruitful as their supporters claim.

Electron diffraction. Considerable technical progress was described in dealing with the diffraction of electrons by gases. The main difficulty in this subject is the extreme variation of the intensity of scattering with angle; if the lower part of the pattern is adequately exposed, the higher parts, which govern the accuracy of the conclusions, cannot be observed.

The main method of overcoming this difficulty is to place a rotating sector over the film during the exposure, so that the observed intensity is reduced according to a known function of scattering angle. With such methods it is possible to observe diffraction patterns down to spacings of about 1·5 A., and thence to derive interatomic distances to an accuracy of about 0·01 A. Many examples of the application of this method were described by workers from Norway, Japan, the United States and Great Britain.

Some extremely interesting photographs of diffraction effects from single crystals were also shown. The possibilities of using electron-diffraction photographs in crystal-structure determination had been pointed out in 1939; but no great progress seems to have been made in this subject. Possibly, considerable difficulties are involved in eliminating the secondary diffraction effects, such as Kikuchi lines, which are given by perfect crystals; but if these could be eliminated or allowed for, the electron-diffraction method might prove to be an extremely useful tool.

To summarize, it may be said that the field covered by the diffraction of X-rays and electrons continues both to expand and to knit itself more closely together. An increasing range of materials has come within the scope of the methods, and connexions are being found between the different methods and techniques that are used. Relationships have been discovered between what were thought to be isolated subjects, and the degree of strength given to these methods of studying matter augurs well for future advances.

H. Lipson

CHEMICAL INDUSTRY IN GREAT BRITAIN

THE discussion on August 10 on "The Changing Face of Chemical Industry" before Section B (Chemistry) at the British Association meeting at Edinburgh was opened by Mr. J. Davidson Pratt. As general manager of the Association of British Chemical Manufacturers, it was natural that Mr. Pratt should make some reference to the report on the British chemical industry which the Association prepared two years ago. That report fully displayed not only the scientific character of chemical industry but also its essentially dynamic nature; and beyond quoting the figures given in that report for the industry's estimated expenditure on research to illustrate his point that for chemical industry research is a necessity —and a costly one—Mr. Pratt did not attempt to recapitulate. He made a second point regarding the number of small units still operating, and that success here demands the same qualities of individuality and initiative which have in the past century been responsible for so many remarkable developments and the rise of many of the best-known firms in the industry.

The complexities of both the scientific and technical sides of the industry were indicated in the paper by Dr. F. Roffey on petroleum chemicals, and in that by Dr. J. C. Swallow on synthetic polymers. Dr. Roffey pointed out that, in very general terms, the petroleum chemical industry, which derives its raw material from petroleum or natural gas, has its main influence on the large-scale production of aliphatic rather than aromatic products. In this it is complementary to the older coal-tar industry, although highly important developments have been based on the use of intermediates derived from both. Since the middle 'twenties, the growth of the industry has been remarkable. Dr. Roffey indicated some of the developments and inter-relations on the chemical side, which, as distinct from the breakdown of any given feed-stock into its component hydrocarbons or closely related groups of hydrocarbons—essentially the responsibility of the oil industry—is the task of the petroleum chemical industry.

Dr. Roffey's review of some of these products which are provided for the field of synthetic plastics, fibres and rubbers linked naturally with Dr. Swallow's review, which aimed at giving a picture both of the overlapping relations of these three types of synthetic polymer and of the possibilities of synthesizing a polymer with the properties required for a specific application. There are, however, limiting factors which prevent the production of these new materials in sufficient quantity for all our needs. The lag of seven to ten years between discovery in the laboratory and successful industrial production has still to be faced, and there have been further economic difficulties since the War. Some of these were indicated in the report on chemical industry, and the orderly introduction of new materials into modern economy represents one of the more difficult tasks facing chemical industry, and the industries which use these products for obtaining new technical effects.

In general, the symposium had an economic or even sociological trend that would have made it almost equally appropriate to Section F. What Mr. Davidson Pratt had observed about concentration on quality and efficiency rather than on quantity and output, as in the earlier chemical industry, appeared to be supported by both the following papers. The economic and social background of the industry was even more prominent in a most interesting paper contributed to the symposium, namely, that in which Mr. H. W. Cremer, following the chairman's opening remarks, dealt with some general considerations, mainly from the point of view of the chemical engineer; but he also directed attention to the need for an informed and alert public opinion to prevent some of the undesirable features of the early development of chemical industry, such as atmospheric and water pollution. He insisted frankly that failure of the general public to make active protest was at least partly responsible for such defects.

Mr. Cremer pointed to a number of factors which are giving rise to a different outlook and to better conditions both inside and outside the industry. The increasing competition from industrially minded countries, by necessitating higher process efficiencies, has in consequence diminished waste of materials in effluents and in atmospheric pollution. Stringency of supplies of raw material, including water, can operate in the same way, while the extension of the industry to include a much wider range of products such as textiles, foods and pharmaceutical preparations, requiring manufacturing techniques of a very different character from those employed in the so-called 'heavy' chemical industry, is giving organic chemical industry the character of a fine-chemical industry. Developments in insecticides and in fertilizers have aligned chemical industry closely with agriculture, and he regarded the prospect opened up by the utilization of plastics as almost limitless. He attached much importance to the disappearance of the old differentiation between pure and applied science, and to the unification of outlook to be seen in the approach

to problems in modern chemical industry. This finds expression in the team-work in which mathematicians, physicists, chemists, biologists, geologists and metallurgists may all participate, and Mr. Cremer thought that, in thus furthering the idea of the unity of science, that co-operation and interchange between universities and industry which is so essential and fruitful may also be stimulated.

Other factors changing the face of chemical industry to which Mr. Cremer referred were the introduction of new constructional materials, with all their implications for the design of plant to operate under more and more exacting conditions of pressure or temperature, the remarkable developments in scientific instruments which are not only increasing the accuracy of control but also making it possible for such control to be automatic or remote, and the contribution of the chemical engineer in the study of selected categories of process operations, based on the same physical principles although their method of application may differ with the properties of the individual product to be manufactured. Besides this, the attention now being given to the safety and welfare of the workers in chemical industry is also affecting its character as well as the design of its plant. The study of occupational diseases has sometimes stimulated research on disease in wider fields, and the industry in its work on toxicology and like matters is concerned with the health and safety of users of its products as well as of those making them. Mr. Cremer believed that the industry is now fully conscious of all its direct and indirect obligations to the public, and that there is now much better prospect of science being properly wedded to industry and, in turn, of industry to civilization.

But it seems equally clear from this symposium that the future of chemical industry will not depend solely on internal factors, but also on whether Government policy and the general social or political climate are favourable. There was implicit concern that fiscal policy may place fresh difficulties in the way of development when obsolescence is so large a consideration and research and development so costly, and whether there will continue to be forthcoming the initiative and individuality, the enterprise and imagination which are required to create and to seize these opportunities.

STUDENT HEALTH IN GREAT BRITAIN

INTRODUCING a symposium on student health before a crowded session at Edinburgh of Section I (Physiology) of the British Association, Sir Andrew Davidson, chief medical officer, Department of Health for Scotland, claimed that no better nor more appropriate recognition of the importance of student health has been recorded than its inclusion in the discussions this year of the British Association. We have been guilty hitherto of neglecting an important group of the community from which not only our men of science but also other leaders of the nation are most likely to come.

Eighty-five thousand full-time students attend universities and colleges under the ægis of the University Grants Committee, and probably as many more attend other central institutions for higher education. In Scotland there are about thirty-one thousand students in all. This very substantial occupational group is subjected to stresses and strains —both physical and mental—which demand special understanding.

The promotion of full health and the prevention of ill-health, with measures for the early diagnosis and treatment of disease, should be the aim of all student health services. Curative medicine must have its place but should, wherever possible, be arranged within the National Health Service. The best features of our school health services and our industrial health service should be incorporated—the personal health programme and the health education work of the former, and the environmental effort of the latter. The approach to student health work should be through physiology rather than pathology.

Stressing the importance of health education, Sir Andrew quoted the Goodenough Committee Report. "A student health service would be one of the means of inspiring the community to a sensible interest in the promotion of health. . . . the service would be a special education for them [students] as providing a practical demonstration of medical practitioners in the role of health officers. Such a demonstration related to a student's own health and problems is likely to make a much more lasting impression than much exhortation."

Of particular interest were Sir Andrew's remarks on research in student health services. In no other section of the community do such excellent opportunities exist for research in health. The combination of an intelligent, young, apparently healthy person and a doctor with reasonably adequate time is unique. There is, too, an almost unexplored field of investigation of a group living through one of life's most critical stages. Inquiries into environmental, social and personal factors, physical exercise, nutrition and so forth can provide invaluable information, which may perhaps indicate routes of development in our health services. There is the added advantage that the student can be closely observed for three to five years, while his later history may even be followed up for a longer period. Where can intelligent co-operation be more readily forthcoming, asked Sir Andrew ?

During the limited time available for eye testing in the medical examination of large numbers of students, anything more elaborate than the monocular Snellen test is usually considered to be impossible. This test, however, fails to reveal many instances of binocular defects, anisometropia suppression, and so on. Dr. R. H. Bolton, of the University of Birmingham, described in an impressively lucid paper how he has adapted the Turville infinity balance to provide a 'screening' test, which, though not yet completely infallible, nevertheless provides a simple test markedly superior to any other screening test in his experience. The Turville infinity balance is essentially an extension of the well-known binocular reading test in which a pencil or narrow strip of paper is held between the eyes and the test type. The pencil is replaced by a sand-blasted septum in the centre of a mirror in which back-to-front letters are reflected and read, different letters being read by each eye. This "gives a satisfactory indication of how the student is using his eyes as a pair and saves a lot of time". By applying a surface-silvered mirror immediately behind a clear-glass septum, but slightly out of alignment, a virtual image of the test letters is seen binocularly immediately above the separated or monocularly seen types, providing a standard for detecting even minor degrees of 'phoria' or faulty

alignment. At a second testing 'station' each student undergoes a colour vision test, a binocular reading test, and near-point phoria test using a Maddox convergeometer. From the subsequent histories of those examined by him, Dr. Bolton confirms the usual view that 'esophores' are more likely to have eye troubles than 'exophores' or 'orthophores'.

As part of a wider study of the socio-medical and environmental background of 2,539 students of all faculties at the University of Edinburgh, Dr. J. G. Thomson has considered the association of these factors with the academic results achieved by 592 medical students from all years except the first, and by a second group of 137 first-year medical students.

Three-quarters of all students and 83 per cent of medicals were from social classes I and II (the upper social classes). Family size does not show the normal variation between the social classes, and students from lower classes obtain academic results as good as those from other classes.

Students entering the medical faculty at ages between twenty-six and thirty showed the best academic results, followed by those who started at less than eighteen years of age. Of the year-group 18–25, those entering between the ages of twenty and twenty-two gave the poorest results of all. There was no evidence in this group that national servicemen did better or worse than non-servicemen, and, of the physical and environmental factors considered, only myopia showed a slight suggestive association with superior academic performance.

In the first-year group, students living at home did less well than those in lodgings approved by the university welfare superintendent. Room-sharing, longer hours of daily travel-time, and differences in recreational habits did not account for this, and the solution was found in a group of twenty-three students from English secondary schools who were very much more successful than any other group. What appeared to be an interesting environmental difference was, therefore, probably the result of pre-university educational factors, or of varying selection criteria.

Presenting a provocative and enjoyable paper on the relationship between physique and physical attainments, habits and behaviour, including delinquency, Dr. R. Parnell, of the University of Oxford, created a stir with a formula based on physical measurements and radiographic heart-size, which not only differentiated sprinters from long-distance runners, but also graded them according to potential performance. He confidently predicted that a particular athlete at the top of his table would win the 1,500-m. race at the Olympic Games at Helsinki next year.

A comparison of heights and weights in the University of Oxford revealed once again that students from the lower social classes are smaller than those from the other social classes. Since, however, students from government grant-aided schools are "taller and heavier than the highest level reached in the general population", Dr. Parnell argues "that the great difference between undergraduates and the general population is probably due to selection" and not to nutritional advantages. Is it not more probable that working-class parents who are ambitious for their children do, as demonstrated in Dr. Thomson's paper, limit the size of their families in order to give them both educational and nutritional advantages?

The classification of physique by methods of standard photography based on the Sheldon technique, and standardized by the work of Tanner in Great Britain and Dupertuis in the United States, has produced evidence in support of those who propound a relationship between physique and behaviour. Dr. Parnell demonstrated the use of the 'fat clock', a graphic method of recording physical measurements and the thickness of the subcutaneous fat, which will be a useful technique for all those who are interested in this work.

In a powerful plea for a deeper appreciation of the problems of the tuberculous student, Sir Alan Rook, of the University of Cambridge, estimated that there are probably close on five hundred undergraduates in sanatoria in Great Britain and more than two thousand in need of medical care or observation for pulmonary tuberculosis. After discussing the problems of adjustment and career selection which face those students who are able to continue their studies while under observation, Sir Alan went on to paint a graphic picture of the frustration, the loss of initiative and desire to work, or the fretfulness and restless anxiety of these young people, progressing all too often to a profound psychological maladjustment, which not only retards recovery but also impedes resettlement after cure.

After referring to the success of Continental students' sanatoria, which he reluctantly classed as impracticable in Great Britain at present, Sir Alan asked that, at least, we should establish something corresponding to the Continental post-cure hostels for tuberculous students.

This must not be thought of as preferential treatment any more than rehabilitation units for industrial workers and 'Remploy' factories can be considered 'preferential'. The correct treatment should be available to all, and Continental experience has shown that the correct treatment for university students includes the mental stimulus of continued teaching and study under medical supervision. It is scarcely creditable to British universities to have lagged so far behind Continental practice in this matter. Now, however, the students of Great Britain are pressing strongly for action, and have collected a large sum of money towards this project. It is to be hoped that Sir Alan's plea will bring them the influential support for which they look so hopefully.

As the speakers freely admitted, much of their work is exploratory and open to criticism or even correction. The important thing is that a start has been made. A regular stocktaking of the health, well-being and occupational efficiency of those on whom the advancement of science will depend in the future will be of great interest to members of the British Association, especially if the approach continues to be "through physiology rather than pathology".

ARMAGH OBSERVATORY

REPORT FOR 1950

THE March issue of the *Irish Astronomical Journal* (1, No. 5; 1951) contains the report on Armagh Observatory for the year 1950, in which Dr. E. M. Lindsay, the director, gives the main items of interest and development for the year. The Armagh–Dunsink–Harvard telescope is now in operation at the Boyden Station of the Harvard Observatory at Mazelspoort, Bloemfontein, where it arrived on October 26, 1950, and was erected under the supervision of Dr. J. S. Paraskevopoulos and Dr. Bok

shortly before the death of the former. The primary mirror has a diameter of 36 in., the secondary mirror 16 in., and the correcting plate 32 in. The photographic plate covers an area of about 18 square degrees, and the scale is 1 mm. = 68″. An exposure print of 61 min. is reproduced and shows the excellent performance of the instrument and its efficiency in the photography of diffuse nebulæ. A member of the staff of Armagh Observatory spends four months of the year on the observational programmes on the Southern Milky Way with the telescope. The report includes a photograph of the instrument. The completion of the objective prism for the telescope is well under way; it will be 33 in. in diameter—the largest in the world—with a 5° angle giving a dispersion of about 400 A. per mm. The cost of the prism so far has been borne by Harvard University and by a grant from the Senate of Queen's University, Belfast.

Dr. E. B. Armstrong commenced erecting the Armagh Schmidt telescope in August 1950, and the final adjustments were being made and test plates taken early this year.

The remainder of the report gives a list of publications, a summary of the meteorological work, the names of a number of visitors, a miscellaneous collection of information on lectures by Dr. Armstrong at Queen's University, the synchronous motors for the meteor cameras, various internal renovations and alterations in the buildings, etc.

A NEW MEASUREMENT OF THE VELOCITY OF RADIO WAVES

By COMMDR. CARL I. ASLAKSON
U.S. Coast and Geodetic Survey, Washington, D.C.

DURING January and February of 1951, I was privileged to assist in some new tests of improved Shoran equipment. These tests were undertaken by the United States Air Force, and in general the methods employed were those developed by me[1-3]. However, several improvements were incorporated in the equipment by the United States Air Force, the most important one being a 'gain-riding technique', whereby the gains were manually controlled and maintained, both at the ground station and in the air, at a constant level. This technique effectively eliminated the 'signal intensity' correction reported in the earlier work.

The lines measured constituted a five-sided figure with a central point. Since the distances between all points were measured, there were fifteen lines in all. These distances varied from 40 to 320 miles, as shown in Table 1.

Table 1

1	2	3	4	5	6	7	8
Line	Ground stations Rate	Drift	Geod. distance	Shoran distance	Shoran minus geodetic	Col. 6 corrected for K	Adjusted V
2–6	2	3	40·6131	40·6041	−0·0090	−0·0033	+0·0008
3–4	1	3	96·7171	96·7049	−0·0122	−0·0083	+0·0024
5–6	1	2	100·3098	100·2988	−0·0110	−0·0054	−0·0007
5–1	1	3	118·9953	118·9840	−0·0113	−0·0074	+0·0002
1–6	1	2	133·0113	132·9985	−0·0128	−0·0072	−0·0009
2–3	2	3	134·9698	134·9546	−0·0152	−0·0095	+0·0013
5–2	1	3	139·1225	139·1127	−0·0098	−0·0059	−0·0025
3–6	1	2	145·8427	145·8276	−0·0151	−0·0095	+0·0006
1–2	3	2	145·8884	145·8768	−0·0116	−0·0059	−0·0029
4–6	1	2	190·5047	190·4889	−0·0158	−0·0102	−0·0013
2–4	1	2	199·1914	199·1735	−0·0179	−0·0123	+0·0002
5–3	2	3	226·9903	226·9698	−0·0205	−0·0148	+0·0010
5–4	1	2	235·5264	235·5042	−0·0222	−0·0166	+0·0023
1–3	2	3	277·0569	277·0347	−0·0222	−0·0165	−0·0003
1–4	1	2	320·1519	320·1271	−0·0248	−0·0192	−0·0002

Probable error of observation = ±0·00118

All stations were tied to the first-order triangulation network of the United States, and the inversed geodetic distances could thus be compared with the Shoran distances.

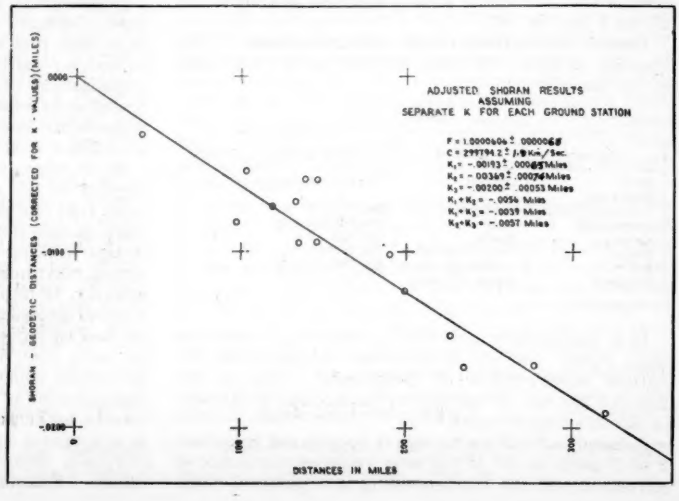
Three Shoran ground stations were used, but only a single airborne station. Each ground station is known to have a small constant error which can be determined by calibration over a known distance. This error varies from about −0·002 mile to −0·003 mile. In the present case it was possible to make an excellent analytical determination of this error from the results of the measurements.

The original Shoran measurements were made using the Anderson value of $c = 299{,}776$ km./sec. Therefore, that velocity must be multiplied by the factor 1·0000606 derived from the adjustment. This results in a velocity of $299{,}794{\cdot}2 \pm 1{\cdot}9$ km./sec.

The solution was made from fifteen observation equations, one for each line measured. The equations were as follows:

$$FS + K_1 + K_2 - E = 0.$$

Column 6 in Table 1 gives the value of E in each equation. Column 7 contains these values of E after correction for the computed ground station values of K, while column 8 shows the V's or the corrections to the distances. The other terms in the equation are defined as follows:


ADJUSTED SHORAN RESULTS
ASSUMING
SEPARATE K FOR EACH GROUND STATION
SHORAN - GEODETIC DISTANCES (CORRECTED FOR K - VALUES) (MILES)
DISTANCES IN MILES

F is the scale factor representing the velocity change from the assumed velocity. The values K_1, K_2, and K_3 are the constant errors in measurement, which are a function of the individual ground stations, and E is the Shoran distance minus the geodetic distance.

The results of the above solution are:

$$\begin{aligned} F &= 1{\cdot}0000606 \pm 0{\cdot}0000065 \\ \text{or } c &= 299{,}794{\cdot}2 \pm 1{\cdot}9 \text{ km./sec.} \\ K_1 &= -0{\cdot}00193 \pm 0{\cdot}00065 \\ K_2 &= -0{\cdot}00369 \pm 0{\cdot}00074 \\ K_3 &= -0{\cdot}00200 \pm 0{\cdot}00053 \end{aligned}$$

The Shoran distance was S.

Thus $K_1 + K_2 = -0{\cdot}0056$

$K_1 + K_3 = -0{\cdot}0039$

and $K_2 + K_3 = -0{\cdot}0057$

The probable errors in these values of K are sufficiently low to indicate that the analytical method of determination is satisfactory.

These results are summarized in the accompanying graph, which shows the adjusted velocity curve together with the individual observations. The derived velocity of 299,794·2 ± 1·9 km./sec. is higher than the one previously reported by me. However, the removal of the troublesome signal intensity error together with other improvements in the equipment and the techniques lend more confidence to the above figure.

In my previously reported value[2] of c, a value of the index of refraction for dry air at 760 mm. pressure and 0° C. of 1·0002835 was used. In the present work I have adopted a value of 1·0002876. That figure is based on the means of a number of measurements made by various observers in the optical band. Warner[4] adopted a statistical value of 1·0002895 ± 0·0000550, basing that figure on the dielectric constant determinations of seventeen workers between 1872 and 1946. Birnbaum, Kryder and Lyons[5] published a value of 1·0002853 for air and 1·0002877 for air as determined from its component gases. Essen[6] recently published a value of 1·0002882. In the same paper Essen states that a new optical equation of Barrel gives a value of 1·0002878. It seems certain that the figure I have adopted is accurate to about 1 part in 10^6.

Essen[7] summarizes recent determinations of the velocity of light. In Table 2 I have added my value to his list.

Table 2

Author	Method	Velocity *in vacuo*	Weight
Birge	Optical	299,776 ± 4 km./sec.	1
Essen and Gordon-Smith	Cavity resonator	299,792 ± 9	1
Bergstrand	Optical	299,793·1 ± 0·26	2
Aslakson	Radar	299,792 ± 2·4	2
Essen	Cavity resonator	299,792·8 ± 3	2
Bol	Cavity resonator	299,789·3 ± 0·4	2
Aslakson	Radar (Shoran)	299,794·2 ± 1·9	

It is particularly noteworthy that these observers used widely varying frequencies, ranging from the optical wave-lengths of Bergstrand, through the 220–300 Mc./sec. of the Shoran band to the 30 Mc./sec. of Essen's experiments.

Aslakson's 1949 value would be reduced by about 2 to 3 parts in 10^6 if the new value of the index of refraction and the corresponding interpolation equation were used. Certainly the close agreement and relatively low probable errors are significant.

At the present time a new series of Shoran measurements is in progress. The value of the velocity assumed in projects now under way is 299,793·1 km./sec. So far, comparisons of measured distances and Shoran distances indicate that this value is correct within 1 part in 150,000.

A more complete report of the measurements described here will be published elsewhere.

[1] Aslakson and Rice, *Trans. Amer. Geophys. Union*, **27**, 459 (1946).
[2] Aslakson, *Trans. Amer. Geophys. Union*, **30**, 475 (1949).
[3] Aslakson, *Nature*, **64**, 711 (1949).
[4] Warner, Radiophysics Laboratory, Commonwealth of Australia, RPR 93 (Aug. 1949).
[5] Birnbaum, Kryder and Lyons, *J. App. Phys.*, **22**, 95 (1951).
[6] Essen, *Nature*, **167**, 512 (1951).
[7] Essen, *Nature*, **167**, 258 (1951).

SCIENTIFIC MANAGEMENT

IN a stimulating article, the warden of Urchfont Manor Residential College for Adult Education suggests that there is a real danger of accepting a number of false propositions in the name of so-called 'scientific management' (*J. Inst. Personnel Management*, **33**, No. 315; May–June 1951). In an analysis of what is implied by the term 'scientific management', Mr. Hunter suggests, first, that there are parts of management in which certain sciences are of use. Good statistical analysis of costs, accurate measurement, controlled experiment on alternative methods of layout or process will clearly be useful and are rightly called 'scientific'. Motion study also might be included, since the human body is in one sense a machine which will function best with certain directions of movement and load. When time study and rate fixing are included among the sciences, a little more doubt creeps in; owing to individual variation in rates of learning and final speeds attained, a subjective element is introduced. Aptitude testing suffers from similar limitations, for the world is full of adaptations successfully made by people with apparently crippling disability.

Secondly, although organization is often included in 'scientific management'—industry is fond of organizational charts and maxims regarding 'the span of control'—it is doubtful whether organization is in any real sense a scientific subject. There is, indeed, a considerable amount of experience regarding organization of, say, a company with many local branches or a flow production plant, but it is scarcely suitable to describe knowledge of this experience as scientific: it is mainly empirical.

It is when the term 'scientific management' is applied to the management of human beings, however, that real muddle begins. The object of management in this field is to get a large number of human beings working together in mutual co-operation and giving maximum output. If there is a science of this activity, it implies that there should be an ordered body of knowledge relating to it and capable of being applied by any competent student. The claim appears to have been made that there are laws of group behaviour which can be ascertained and used in the management of groups. If this were true, it would clearly be of immense importance to industry, since a systematic application of these laws for defined purposes should result in producing co-operative effort. Examining the nature of this claim more

closely, Hunter considers the simple and semi-technical factors such as fatigue, boredom, lighting, rest pauses and hours of work. From this it might appear that a simple or at least a direct correlation between variations of these conditions and output might be established. But at once the Hawthorne experiment springs to mind, apparently proving that the effect of such variations, if any, can be completely masked by the simple fact that the working group was stimulated to higher effort by the evidence of management interest in their work.

The first difficulty in producing a science of management is that the material to be handled insists on taking a hand in the experiment. Moreover, there is little evidence that this reaction will itself be regular, or predictable. The shop steward may be flattered or co-operative, or he may decide that the whole experiment is designed to save manpower and will endanger his job.

Hunter then goes on to consider the nature of the knowledge which the psychological scientists in industry bring back to the manager who employs them.

The psychologists discover that healthy rivalry can increase production, and advise the introduction of merit rating and merit awards. Perhaps this succeeds; but perhaps it does not, and instead produces jealousy and suspicions of favouritism, in which case another scientific investigation will produce a new diagnosis—that there is too much competition and jealousy due to merit rating. They discover that fear plays an enormously important part in determining behaviour; that a suppressed fear may have results not apparently connected with its cause; for example, a man in fear of unemployment may suddenly be rude to the foreman. They discover that men have a sense of dignity and will react unfavourably if this is affronted, that praise and blame work better than indifference, and that natural leaders appear in small groups and may lead in good or bad directions. Experience of individual psychology should warn us that the method of detailed analysis of unique cases cannot possibly produce a system of scientific rules applicable to industrial groups. Each group is, to begin with, a collection of unique individuals; each group will be coloured by its own unique history, that of the factory or its social environment; each will be affected differently at different times by current social and political attitudes absorbed from the general atmosphere of society. Possibly a year's work by an experienced team of investigators might unravel a great deal of the psychology of a group in the machine shop, and describe it in a book of considerable length. Industrial management, however, cannot possibly work at this rate.

The manager's job in industry, as that of the military commander, is to get co-operation from a group as a result of hundreds of different personal motives and influences of history and tradition which analysis might discover among any single group. Moreover, he must succeed not only with the machine shop but also with the typists and with the whole factory, composed of many utterly different groupings. Analysis cannot give him these answers. The history and experience of human leadership will, however, tell him what qualities he must show to obtain the same good result from widely different groups.

Hunter believes that the search for 'scientific management' is a search for the lazy man's way of doing the job, for a book of rules which any manager can use. If there is such a book it is one which tells of the personal qualities which the manager must show; of the self-discipline, the imagination, and the love which he has somehow to create, very painfully, in himself in order to lead others.

In conclusion, Hunter insists that he does not want to abandon observation of industrial situations or to cease experiment on organization. The excellent work which has been done on methods of selecting foremen or of drafting joint production council constitutions, the analysis of absenteeism or the organizational chart—all these have been of high value, since they provide a better channel through which leadership can flow. But he also insists that they will never provide a science of management, because there is no such thing. T. H. HAWKINS

FOREST POLICY IN AFRICA

UNDER the question of policy and legislature in the annual report of the Forest Department of Uganda for the year ending December 31, 1949*, the following appears: "African Local Governments are being encouraged to play an increasingly more active part in forestry work, especially in areas which have been declared to possess adequate forest estates or which are within appreciable distance of attaining that objective. As time goes on District Forest Officers will act less and less in an executive capacity in so far as local reserves, Crown Land, and the supervision of local Government Staff are concerned, and more and more in a true advisory capacity."

Such a statement is all right on paper, but its practical implications must be considered. Forestry is rather different from other branches of administration in that policies must be thought out for centuries ahead; merely changing, for political reasons, an administration from British to African in no way alters the true relation of the forest to the countryside or to the local economy. The only way to preserve forests and to improve and restore those which have been badly exploited is to place them under the *direct* administration of a staff trained in forest methods from the highest ranks to the lowest; and they must know their job and be granted annually adequate funds to carry it out. For forest work entails adequate and constant supervision from the time of obtaining the new young crop of trees until the day they come to maturity—50, 100, 150, 200 or even more years later—as is being practised in France under modern conditions. Rotations may and will be shorter in the tropics. But more rapid growth entails closer supervision and in many cases a larger staff.

From the beginning of this century some of the Colonial administrations have given in the annual forest reports statements of their forest policies; but it has been little more than words. The matter now becomes more serious. If the Africans are to enjoy in future more executive authority in charge of forests, it becomes essential that the proposed position of the trained forester, and what his authority within the forest consists of, should be closely and clearly defined. Otherwise the deterioration of the African forest estate is certain. E. P. STEBBING

* Uganda Protectorate. Annual Report of the Forest Department for the Year ended 31st December, 1949. Pp. iv+54+10 plates. (Entebbe: Government Printer, 1950.) 3s.

EVALUATION OF DISINFECTANTS

At the British Pharmaceutical Conference, held at Harrogate during September 10–14, the chairman, Prof. H. Berry, in his address entitled "A Review of Disinfectants and Disinfection", emphasized the importance of disinfection both to the public health and to pharmaceutical practice. This subject, he said, is studied in all its aspects only in schools of pharmacy, and the modern pharmacist should be qualified to give expert advice on disinfectants and to evaluate commercial claims made for them; he should be proof against "high-powered sales talk" about them. In his address, Prof. Berry discussed with refreshing vigour the question of what constitutes a good disinfectant. Controversy about evaluation of disinfectants revolves, he said, around the type of test represented by the Rideal–Walker test and its product, the so-called phenol-coefficient. This biological test is still misunderstood and is often "misused in advertisements to gull the uninformed layman", but it has turned useless disinfectants off the market. Prof. Berry discussed its defects and explained why he considers that it is a badly designed test which "cannot by any stretch of the imagination be translated into terms of therapeutic activity or practical applicability or utility". Some disinfectants, such as 'Lysol', cetrimide and acriflavine, do not need a biological test; they can be, and are, controlled by chemical or physico-chemical specifications, such as those that are given in the British Pharmacopœia and its Codex.

The real problem, however, is the evaluation of the utility of a disinfectant after it has been standardized. For this the results of many diverse tests are required, and Prof. Berry discussed these. In Great Britain there is no official body which will adjudicate on new disinfectants, nor is the existing legislation for the control of claims made for them effective, although many of the British Dominions and the United States have attempted their legislative control. Prof. Berry commended, however, the Medical Research Council's valuable Memoir No. 11, entitled "The Control of Cross-Infection in Hospitals" (revised edition; pp. 49; London: H.M. Stationery Office, 1951; 1*s.* 9*d.* net), which gives in its Appendix A advice to hospitals on the disinfectants to be used for various purposes; he expressed the hope that the Ministry of Health will adopt a similar method of dealing with disinfectants on the open market.

The remainder of Prof. Berry's address was devoted to a useful discussion of the valuable properties, and also the limitations, of the quaternary ammonium compounds, which are challenging, in certain fields of use, some of the established disinfectants. The address concluded with a brief, but interesting, account of the discovery that some substances which were believed to kill micro-organisms quickly do not, in fact, kill them, but merely inhibit them, so that they can be revived by treatment with 'revivors', among which are ammonium sulphide and certain thiol compounds. Substances have been found which will revive organisms treated with iodine, hypochlorites and formaldehyde, but none is yet known that will revive organisms treated with phenol. Certain thiol compounds, such as glutathione, occur naturally in the body, and there is evidence that, if pathogenic organisms treated with mercury compounds are injected into the body, they may be revived and may become infective. The evaluation of disinfectants must take account of developments of this kind. Revivors can be used to find out whether disinfectants have, in fact, killed organisms.

In conclusion, Prof. Berry urged that the older disinfectants should not be lightly given up. The hypochlorites are, he said, very valuable, and he had great confidence in the phenolic preparations, 'Lysol', 'Black Fluid' and 'White Fluid', the wide non-specific action of which makes them very reliable. He made a special plea for 'Lysol', but added that the hospitals do need a non-toxic, non-irritating phenol preparation the other properties of which are not inferior to those of 'Lysol'.

CARNEGIE UNITED KINGDOM TRUST

The thirty-seventh annual report of the Carnegie United Kingdom Trust, 1950*, covers the completion of the Trust's first post-war quinquennium, and by the end of the year the grand total of grant payments by the Trustees had reached £4,065,555. During its thirty-seven years, the Trustees have thus been able to distribute to beneficiaries more than twice the amount of the original endowment of the Trust of £2 million, and at the same time to increase the income from the original £100,000 a year to rather more than £130,000. More than a third of the total expenditure has been on the development of library services which, as explained in last year's report, will now continue without further financial assistance from the Trustees. Nearly £250,000 has been devoted to playing-fields, mostly within the period 1926–40; but the combined effect of the Physical Training and Recreation Act of 1937 and the Education Acts of 1944 has been to place responsibility in this matter on the local education authorities. Under the same Acts, central and local authorities are now responsible for grants to village halls, to which, if all outstanding promises are taken up in full, the Trust has contributed more than £180,000.

More than £150,000 has been provided for community centres and the like, and about £110,000 on schemes of land settlement, operated by the Land Settlement Association, which, under the Agriculture Act of 1947, is now responsible to the Ministry of Agriculture. Some £450,000 has been provided for youth services and nearly £50,000 for the development of museum services, while on the Bureau of Current Affairs, now to be terminated, £123,344 has been expended. While the Bureau has not been able to establish itself as a self-supporting institution, the Trustees state that they do not regret having made the experiment to find out whether a method that had proved outstandingly successful during the War could be made economically self-supporting in time of peace. The Trustees also terminated at the end of 1950 their support of youth hostels, but the allocation to the National Federation of Young Farmers' Clubs is being spread over six years, instead of the five years originally contemplated. An individual survey on behalf of the Trust is now being undertaken by Mr. John Mack, Stevenson lecturer in citizenship in the University of Glasgow, of agencies and activities concerned with juvenile delinquency, with the object of directing attention to any gaps which might be filled by the action of either statutory or voluntary bodies in furthering existing schemes or initiating new ones.

* Carnegie United Kingdom Trust. Thirty-seventh Annual Report. Pp. viii+49. (Dunfermline: Carnegie United Kingdom Trust, 1950.)

Plans for the quinquennium 1951–55 include an increase in the allocation for the development of museum services from £30,000 to £40,000, in part with the object of strengthening the administration of the Museums Association itself. For the Councils of Social Service of England, Scotland, Northern Ireland, and Wales and Monmouthshire, £27,750 has been allocated, and a sum of £30,000 for family case-work by the Family Welfare Association and Family Service Units. With allocations of £45,000 for music and drama and £5,000 for the visual arts, the total allocation for the new quinquennium is £147,750, and there is thus some three-quarters of the Trust's funds for the period still available for allocation.

RECURRENT LONG LEAVE FOR UNIVERSITY TEACHERS

THE seventeenth issue of *Communication* contains the report of the International Association of University Professors and Lecturers on recurrent long leave. By this is meant the recurrence of substantial periods of leave over and above ordinary annual vacations; the most usual arrangement is that every seventh year is recognized as a year of leave of absence from the place of normal occupation. It is well known that some universities have such schemes, while others have not. It has not been generally known precisely which universities fell into which category, nor has there been any clear knowledge as to what variations of the typical scheme there might be in universities which operate recurrent long leave schemes. A suitable questionnaire was therefore sent to fifty-eight countries where universities exist. Thirty-seven of these have replied, fifteen of them reporting that they have no regular system for long leave. These are Sweden, Finland, France, Switzerland, Belgium, the Netherlands, Austria, Hungary, Czechoslovakia, Germany, Eire, Italy, Mexico, Chile and Bolivia. This does not mean a notable lack of interest on the part of either staff or authorities. Eire (Trinity College, Dublin), for example, though having no system, does occasionally give long leave when a member of staff is invited to spend some time in another university. In the University of Brno, a professor or his associate is occasionally granted leave with full salary for study for a period of, say, three months to a year. Similarly, the University of Chile has provision for granting leave for, say, six months on full salary for study purposes—each case being considered on its merits. In Finland, the University of Abo grants leave of absence with full salary and superannuation, the recipient usually having the obligation of paying a deputy.

The other twenty-two countries have recognized systems for recurrent long leave, although in some of the countries, like Canada, Great Britain and the United States, by no means all the universities have any definitely established systems; it is in the British Commonwealth of Nations and in the United States that the practice is most firmly rooted. The list of countries in which some or all of the universities have systems for recurrent long leave is as follows: Australia, Burma, Canada, Ceylon, China, Denmark, Egypt, Greece, Iceland, India, Israel, Lebanon, Malaya (Singapore), Norway, New Zealand, Philippine Republic, South Africa, Trinidad, Turkey, United Kingdom, the United States and Yugoslavia. From the data supplied it is clear that there is a widespread desire among the universities of the world that a regular leave system should operate. Many individuals, both members of the teaching staff and administrative authorities, of several universities, have expressed their views strongly in support of the system. The general aim would appear to be a scheme on 'sabbatical' lines in the sense that approximately every seventh year should be available for leave. The majority, however, both of those who give it and of those who take it, prefer that the leave be spent usefully in study or research, while travel and rest are not excluded.

Although on paper some of the schemes appear to be satisfactory, they may not be completely realistic. In the Hebrew University of Jerusalem the scheme would appear to be working well, a high percentage of members of staff taking advantage of it. In Egypt and Ceylon advantage is taken of the opportunities offered. The New Zealand schemes which have been quite recently financed by a special grant from the Department of Education are likely to prove very attractive. On the other hand, there would appear to be a good deal of imperfection in the machinery of some of the others which considerably reduces their effectiveness.

In most cases full pay is continued during leave, although in some there is a downward adjustment. On the other hand, Egypt and Lincoln (New Zealand) add a cost-of-living bonus. Generally, the staff-strength of a department provides for leave to a teacher without the need for a substitute; but where a substitute is required, in some cases the institution provides for the payment and in others it is the individual who pays in part or in full. One of the major expenses attending leave is that of travel. Long-distance passages are covered or partially met by a grant-in-aid by about half the universities who have replied; in other cases the whole cost falls on the member. In the latter event only teachers in universities where the salaries and other emoluments are relatively good can avail themselves of the leave or attempt to undertake long-distance travel. Another difficulty which arises in some cases is that, if a man is to take his wife and family with him, it naturally adds a good deal of expenditure, whereas if he leaves them behind he has two establishments to finance. Interesting examples in this connexion are Ceylon, Egypt, Western Australia and Yugoslavia. In Ceylon a travelling allowance is made for a wife, in Egypt for both wife and children, in Western Australia a larger house allowance is made in the case of a married man on leave, and in Yugoslavia the needs of the family are arranged for by paying to them the member's salary, the member on leave receiving instead his living and travelling expenses.

In reviewing the replies to the questionnaire, the Association recommends that a system of long leave at recurrent intervals should be established in all university institutions of the world. Where such a system cannot be established, all facilities for *ad hoc* refresher or study leave should be granted. Such leave should be with full pay and superannuation and adequate travelling allowances. If it should be necessary to pay for a substitute, funds should be provided by the institution for this purpose. The leave should be devoted to research, travel, rest or any other purpose to which the academic authorities could take no reasonable objection.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Detection of Sugars by Paper Chromatography

Since the introduction by Partridge[1,2] of filter-paper chromatography for the identification of sugars, the method has been widely applied by many workers, and has often proved of great value in detecting small quantities of a carbohydrate in the presence of large amounts of other sugars. With some justification, the tacit assumption, 'one sugar, one spot', is commonly accepted. We have made some observations which seem to call for greater care in the interpretation of chromatograms, and it is for this reason that the following facts are reported, although our knowledge of the phenomena described is still far from complete.

During an investigation of the sugars present in diabetic urines, three spots were observed when paper chromatograms, developed with the upper phase of a mixture of *n*-butanol (40 per cent), ethanol (10 per cent), water (49 per cent), and ammonia (1 per cent), were sprayed with aniline hydrogen phthalate[3], benzidine[4], or *p*-anisidine hydrochloride[5]. One of these spots had an R_F value identical with that of a reference glucose spot; the R_F values of the other two were, respectively, 33 per cent and 78 per cent of that of the reference spot. The slowest-moving of these substances stained with naphthoresorcinol[3] (Fig. 1), but not with ammoniacal silver nitrate[1]; on the other hand, the middle spot was observed with the latter reagent. No appreciable amount of ninhydrin-reacting material was present in the urine. On changing the developing solvent to *n*-butanol (40 per cent), acetic acid (10 per cent) and water (50 per cent), only glucose could be observed in the urine, while in *n*-butanol saturated with water the slowest spot moved only 11 per cent of the distance of the glucose spot and there was extensive streaking.

In connexion with other work on which we were engaged, samples of the polyglucoses dextran and

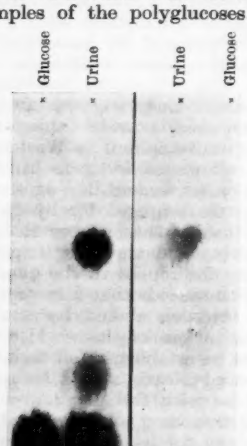


Fig. 1. Left, sprayed with aniline hydrogen phthalate; right, sprayed with naphthoresorcinol

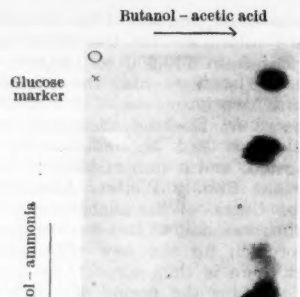


Fig. 2. Urine introduced on to the paper at position ○. Chromatogram developed with (1) butanol–ammonia, (2) butanol–acetic acid, and sprayed with aniline hydrogen phthalate. Glucose markers introduced at positions × before second development

starch were hydrolysed with 2*N* sulphuric acid in sealed tubes for 6 hr. at 100° C. The resulting solutions were neutralized either with barium carbonate or by using the desalting technique of Consden *et al.*[6]. When each hydrolysate was analysed on a chromatogram developed with butanol–ammonia, only glucose was detected if the amount of sugar employed was about 20 μgm.; but when this quantity was increased tenfold a spot was found which, in its R_F value and in its behaviour towards the spraying reagents mentioned above, was identical with the slowest one observed in the urine samples. However, it was never obtained as strongly as in the former case. This spot was again apparent when, in a further experiment, glucose itself was submitted to the acid treatment, followed by neutralization. Moreover, when a large quantity (200–300 μgm.) of pure glucose, freshly dissolved in water, was run on a chromatogram, the same spot could just be observed if the paper was sprayed with aniline hydrogen phthalate and illuminated with ultra-violet light. In some of these experiments the presence of the 'middle spot' was noted; but, due both to its low intensity and to its close proximity to the excessively strong normal spot, it was not always possible to claim its presence with certainty.

Other aldoses—both pentoses and hexoses—were found to behave similarly; but no extra spots were observed with the ketoses fructose and sorbose. The general pattern of the extra spots obtained with the aldoses was similar in all cases, and in the case of galactose the relative mobilities of the three spots were the same as in the case of glucose. However, this was not true for all the sugars examined; the slowest-moving spot obtained with ribose, for example, moved 44 per cent of the distance of the normal ribose spot. Similar phenomena have been noted with some partially methylated sugars, although the number of extra spots and their relative positions vary in a manner which appears at the moment to be almost haphazard.

When the urine sample referred to originally was run on a two-dimensional chromatogram, developed first with butanol–ammonia and then with butanol–acetic acid (Fig. 2), it appeared that all the spots

reverted to glucose in the second solvent. Later, when the spot which was the least mobile in butanol–ammonia was eluted from a paper with water, using the technique introduced by Dent[7], and re-run on a chromatogram developed with the same solvent, it appeared in its original position; but if dilute acetic acid was used as the eluant the normal glucose spot was obtained on the new chromatogram. Under the same conditions the middle spot also reverted to glucose with acetic acid; likewise, the two extra spots produced from glucose by the sulphuric acid treatment were re-converted to the normal spot with acetic acid.

From the foregoing, therefore, it will be seen that we have observed on paper chromatograms phenomena which are of importance in the analysis of sugar mixtures, particularly in the examination of metabolic fluids and in the determination of the component sugars in a polysaccharide. Whether these various interconvertible spots differ in their internal structures, or whether condensation or addition reactions are involved, it is, at present, impossible to say; but the matter is being investigated further.

We are indebted to the Colonial Products Research Council for financial assistance.

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Paper Partition Chromatography of Alcohols using the Potassium Xanthogenates

A few drops of the alcohol in a small test-tube are treated with 0·5 ml. of pure carbon disulphide and 0·1 gm. of pure powdered potassium hydroxide and the mixture shaken for some minutes. The liquid phase is decanted to another test-tube, evaporated and the residual xanthogenate dissolved in a drop of water. The resulting solution is developed by paper partition chromatography (ascending method) using alkaline butanol (2 per cent potassium hydroxide) as solvent. About twenty hours is required. The location of the xanthogenates on the paper is detected easily by their dark brown luminescence under ultra-violet light or by the yellow or blue colours produced by spraying with Grote's reagent[1]. In the case of solid alcohols, the xanthogenate formed is dissolved in formamide and developed in the same way. The R_F of formamide solutions of potassium xanthogenates, however, indicates, assuming the following reaction, the values of the corresponding ammonium xanthogenates:

$$ROCSSK + HCONH_2 + H_2O = ROCSSNH_4 + HCOOK$$

A few millilitres of ethanol, containing a trace of methanol, in a test-tube is treated with carbon disulphide and potassium hydroxide as above and is shaken for twenty seconds. After evaporation of the liquid layer, the residue of potassium xanthogenate is developed as above.

In this case two spots, corresponding to the potassium xanthogenates of methanol and ethanol respectively, are recognized clearly by ultra-violet light. Both spots appear at first yellowish in colour on spraying with Grote's reagent, but the spot of the latter alcohol turns brown in half an hour whereas that of the former still remains yellow. By using this method, 0·1 per cent of methanol contained in ethanol is easily detected. Limit of identification: methanol 18 γ, ethanol 25 γ.

The R_F values for alcohols, obtained by the potassium xanthogenate method, are as follows:

Methanol	0·23	*iso*Amyl alcohol	0·62
Ethanol	0·35	Benzyl alcohol	0·45
*iso*Propanol	0·44	Octyl alcohol	0·17
*iso*Butanol	0·54	*cyclo*Hexanol	0·04
n-Butanol	0·55	Ethylenechlorohydrin	0·91

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Partition Paper Chromatography of Some Organic Acids

In the course of studies on the metabolism of bacteria, our attention has been focused on the question of partition paper chromatography of organic acids, especially those occurring in living bacterial cells. The present communication describes an attempt to examine the possibility of detecting and resolving organic acids by use of paper chromatography.

The technique employed by us was essentially the same as that of R. Consden, A. H. Gordon and A. J. P. Martin[1]. As a developer, we used phenol saturated with water; as a stationary phase, we used water saturated with phenol. To prevent ionization of organic acids, the atmosphere of our chromatographic chamber was saturated with the vapour of formic acid (see J. W. H. Lugg and B. T. Overell[2]). The paper strips were placed after development in an oven at 110° C. for 15 min., or were dried at room temperature for 24 hr. Then the chromatograms were treated with a solution of a suitable indicator. It has been shown that 0·04 per cent (w/v) alcoholic solution of bromphenol blue gave the best results as regards the stability of revealed spots, although the bromthymol blue seemed to be more sensitive. The locations of some organic acids were also verified by their fluorescence in ultra-violet light.

Unfortunately, we have at our disposal only a limited number of organic acids known to be common metabolites of living cells. The experiments have been conducted both with aqueous solutions of single, chemically pure acids, and with their mixtures. The R_F values were determined as well as standard deviations and 95 per cent confidence intervals, which will be presented elsewhere.

We find that in concentrations ranging from 0·5 to 5·0 per cent (w/v or v/v) there was no apparent influence on R_F values of the acids examined. Although the size and intensity of the spots seem to be proportional to the concentration of acids present, we observed that some acids form more intense and larger spots than would be expected from their concentrations. No doubt this phenomenon is closely connected with the structure of the acid molecule in question.

We did not succeed in recovering uric acid, probably due to its insolubility in water. Among the organic acids under investigation the volatile ones (formic, acetic, propionic and camphoric acid) were not detectable on the chromatograms. In the case of halogenated derivatives of acetic acid, the R_F values were unstable and varied greatly from experiment to experiment.

The R_F values of the acids examined showed no differences greater than the experimental error when the experiments were carried out with one acid or with a mixture of acids. Some acids such as *p*-aminobenzoic, benzoic, salicylic, tannic, lactic and ascorbic gave a relatively high percentage of discrepant results, which were rejected in the calculation of mean R_F values. With an improved technique, better results would be expected (for example, that of F. A. Isherwood and C. S. Hanes[3]).

We have been interested to find a numerical relationship between the structure of a chemical group and its influence on R_F values of organic acids. From a comparison of R_F values of two acids the theoretical R_F value of a group constituting the difference between these acids may be calculated. In such a manner we have determined approximately so-called ΔR_F, that is, an increase or decrease of R_F value caused by incorporation of a given group, for the following chemical groups:

1. $\Delta R_F(\text{C})^{\text{I}} = +1{\cdot}23$ (for the first C atom of aliphatic chain).
   $\Delta R_F(\text{C})^{\text{II}} = +0{\cdot}20$ (for the second C atom of aliphatic chain).
   $\Delta R_F(\text{C})^{\text{III}} = +0{\cdot}10$ (for the further C atoms of aliphatic chain).
2. $\Delta R_F(\text{COOH})^{\text{I}} = +0{\cdot}55$ (for the first COOH-group).
   $\Delta R_F\ \text{COOH})^{\text{II}} = -0{\cdot}45$ (for the second COOH-group).
   $\Delta R_F\ \text{COOH})^{\text{III}} = -0{\cdot}25$ to $-0{\cdot}30$ (for the further COOH-groups).
3. $\Delta R_F\ \text{OH}) = -0{\cdot}22$ (in the aliphatic acids).
4. $\Delta R_F(\text{NH}_2) = -0{\cdot}27$ (in the aliphatic acids).
5. ΔR_F benzene ring) $= +1{\cdot}42$.
6. $\Delta R_F(\text{COOH})\text{cycl.} = -0{\cdot}55$ (the same value in all positions).
7. $\Delta R_F(\text{OH})\text{cycl.} = -0{\cdot}22$ (if attached to any atom of carbon of the benzene ring).
8. $\Delta R_F(\text{OH})\text{cycl.} = \pm 0{\cdot}00$ (if present in a side-chain).
9. $\Delta R_F(\text{NO}_2)\text{cycl.} = -0{\cdot}15$ (in the case of picric acid).
10. $\Delta R_F(\text{SO}_3\text{H})\text{cycl.} = -0{\cdot}48$ (if attached to benzene ring).
11. ΔR_F(N or NH or NH_2)cycl. $= \pm 0{\cdot}00$ (irrespectively whether present in the ring or in the side-chain).

It appears advantageous to control experimentally obtained results by comparison with the theoretical R_F values.

The mean R_F values for a number of acids were as follows: *p*-aminobenzoic, 0·87; ascorbic, 0·46; aspartic, 0·36; benzoic, 0·86; citric, 0·26; fumaric, 0·64; glucuronic, 0·22; lactic, 0·79; malic, 0·43; malonic, 0·54; mandelic, 0·86; nicotinic, 0·89; oxalic, 0·33; picric, 0·75; sulphosalicylic, 0·26; tannic, 0·19; tartaric, 0·21; pyruvic, 0·35.

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Identification of Sulphonamides by Paper Partition Chromatography

The identification of sulphonamides in biological fluids is usually attempted by microscopical examination of crystals and by the use of various, rather non-specific, colour reactions[1]. Since it is common for only small quantities of fluid to be available, it was decided to investigate the possibilities of paper partition chromatography.

The method of ascending chromatography described by Williams and Kirby[2] was used in preference to the usual procedure, this method being more convenient when dealing with six or seven 'spots'. Unfortunately, no single solvent could be found which would separate all the sulphonamides to an extent permitting identification. It was found, however, that the sulphonamides tend to fall into two classes, namely, those separable with a basic solvent and those separable with an acidic solvent. By using either of or both these solvents, the sulphonamides can be separated and identified. The R_F values of some of the sulphonamides in common chemotherapeutic use are given in the accompanying table.

R_F Values

Sulphonamide	*n*-Butanol/ammonia	*n*-Butanol/acetic acid
Sulphaguanidine	0·43	0·36
Sulphathiazole	0·48	0·46
Sulphanilamide	0·56	0·42
Sulphadiazine	0·24	0·50
Sulphamezathine	0·48	0·48
Sulphamerazine	0·34	0·50
Sulphacetamide	0·71	0·44
Sulphapyridine	0·70	0·51

The solvents are prepared as follows:

(*a*) *Acid solvent.* 50 ml. of *n*-butanol is mixed with 15 ml. of glacial acetic acid and 60 ml. of distilled water. The mixture is well shaken in a separating funnel and allowed to separate. The lower aqueous layer is discarded and sufficient *p*-dimethylamino benzaldehyde added to the remaining solvent to give a concentration of approximately 0·5 per cent.

(*b*) *Basic solvent.* 40 ml. *n*-butanol is mixed with 10 ml. of ammonium hydroxide and 30 ml. water. The mixture is shaken up as with the acid solvent, separated and *p*-dimethylamino benzaldehyde added to the organic layer to give a concentration of approximately 0·5 per cent.

The paper used was a sheet of Whatman No. 1 filter paper measuring approximately 20 cm. × 25 cm. A base-line was drawn about 3 cm. from one end and approximately 0·01 ml. quantities (containing 5–15 gamma) of solutions of each of the sulphonamides in *N* hydrochloric acid spotted on the base line at intervals of 2–3 cm. At the same time an unknown sulphonamide solution was 'spotted' on the base line. The spots were then sprayed with Ehrlich's reagent (2 per cent *p*-diamethylamino benzaldehyde in hydrochloric acid) and the filter paper rolled into a cylinder and clipped at the top end with a paper clip.

Two such chromatograms were then placed in Petri dishes containing the solvents, each covered with a bell jar, and irrigation was by capillary attraction for 6–12 hr. Then the papers were removed and, if necessary, sprayed with Ehrlich's reagent. This has never been found necessary after the acid solvent has been used; but the spots usually become faint after irrigation with the basic solvent. From the

position of the unknown spot on both chromatograms, the nature of the unknown can be determined.

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Elastin from Human Tissue and from Ox Ligament

The starting material for the majority of the reported analyses of elastin has been ox ligamentum nuchæ subjected to long periods of boiling in water, the simplest of the methods described by Stein and Miller[1].

Human aorta has been treated in this fashion, and also boiled in frequent changes of 1 per cent acetic acid, a treatment which has been proved by Gross[2] to remove all structurally intact collagen, as demonstrated by the electron microscope. A hydrolysate of material subjected to prolonged treatment by either of these methods shows on chromatography a far greater concentration of basic amino-acids and hydroxyproline than would be expected from "pure elastin" (cf. Bowes and Kenten[3], and Neuman[4]).

Similar chromatograms to those reported by Bowes and Kenten can, however, be obtained from hydrolysates of aorta tissue which has been boiled for five days with frequent changes of between 50 and 100 volumes of 40 per cent urea solution. It might therefore be concluded that certain collagenous substances are more difficult to remove from human tissue than from ox ligament; but that after the complete removal of such proteins the insoluble residue is very similar if not identical in both species, and to this the name 'elastin' could appropriately be given.

Doubt, however, is cast on the validity of this definition of elastin, since it has been shown that the resistance to solution in 40 per cent urea solution of elastin preparations from both ox and human tissues is not absolute, as reported by Stein and Miller, but is a function of the liquor ratio. The whole of an elastin preparation will pass into solution if the volume of the urea solution is raised to between 100 and 200 times that of the solid.

Similarly there are indications of heterogeneity in the residues after treatment with 50 volumes of urea solution. Differences in composition, notably with respect to proline, are observed between the material dissolved from these residues and that remaining after attack by pancreatic elastase[5].

The definition for elastin, therefore, now becomes rather vague. Under the electron microscope, certain branched and rather ill-defined structures are identified as collagen-free elastin. Chemical analysis shows that these preparations are still contaminated with material having some of the significant amino-acids of collagen. A chemical definition of purity based on insolubility in urea is also suspect, since the amount of urea available alone determines the extent of solution.

A fuller examination of the chemical analysis of various preparations obtained by the action of urea and of elastase on both human and ox tissues is in progress. These results, together with corresponding electron microscope studies undertaken in co-operation with the Department of Biomolecular Structure of this University, will be published elsewhere.

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X-Ray Micro-radiography of Biological Specimens

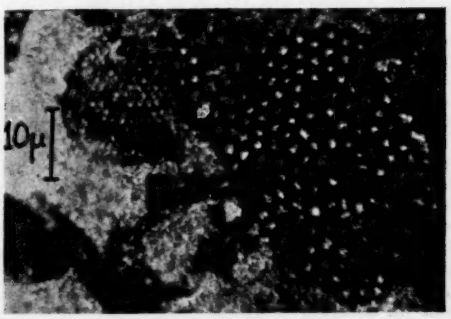
A highly loaded micro-focus X-ray tube[1,2] was used for taking X-ray photographs of microscopic specimens. Engström and others[3–5] have established a strong case for this kind of micro-radiography and have obtained remarkable photographs of microscopic sections in a wave-length range of 5–10 A. using a special tube with a focus of moderate size.

It can easily be shown that even with the fine focus now available ($4\,\mu \times 40\,\mu$) it is advisable, in this wave-length range, to rely entirely on optical magnification of shadow-graphs and to place the specimen close to a photographic plate of high resolution. For, in the case of direct shadow enlargements, the definition can never be better than the dimension of the focus, and even for a point focus at a reasonable distance from the specimen, it is limited by diffraction to less than the resolving power of a maximum resolution plate. It is entirely different, of course, when optical elements proper are used, as discussed by Kirkpatrick and Baez[6,7].

The actual advantage a fine focus may provide over Engström's arrangement lies rather in the less critical spacing between plate and specimen and in the possibility of placing a monochromator between specimen and tube. This permits operating the tube at the normal accelerating voltage of 40–50 kV., where the output of long wave-length continuous radiation is high.

We cut out the short wave-length X-rays by total reflexion at an optical flat, which was set to the critical angle for the wave-length required. It was slowly oscillated in its plane during exposure to avoid the striations[8], which are due to imperfections of polished surfaces.

The accompanying reproduction shows a microscopic enlargement (× 1,000) of diatom fragments taken at a wave-length of about 7·5 A. in 40 min. on a Kodak maximum-resolution plate. Image points



0·5 micron apart are clearly resolved. The specimen was deposited on a collodion film placed 0·2 mm. in front of the plate. The X-ray tube had a 10-micron aluminium window, and the space between this window and the plate was evacuated. The reflector was 4 cm. long and the specimen placed 16 cm. from the focus. These dimensions were chosen to make use of existing gear. The focus-specimen distance can be reduced to at least half without affecting the resolution. This would reduce the exposure time to about 10 min. Another factor of 2 could be gained by using a tungsten anti-cathode instead of the copper target of our tube. The glancing angle by which the X-rays are reflected, and hence λ(min.), changes slightly across the object plane. The effect is easily calculated and amounts to about 2 A./mm. across the specimen for a focus to specimen distance of 16 cm.

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Phosphorus Trifluoride–Hæmoglobin

There are numerous examples of complex compounds formed by trivalent phosphorus compounds which have an electron pair available for the formation of dative bonds[1], and recently this knowledge has been extended by the preparation of phosphorus trifluoride complexes of divalent platinum[2]. There is a close analogy between the lower halides of phosphorus and carbon monoxide in such compounds, and this analogy has been strengthened by the recent preparation of the tetrakistrihalogenophosphine nickels, $Ni(PCl_3)_4$ [3], $Ni(PBr_3)_4$ [4], and $Ni(PF_3)_4$ [4]; the latter is a volatile liquid similar to nickel carbonyl, $Ni(CO)_4$. It was therefore thought that phosphorus trifluoride might form a complex with ferrohæmoglobin similar to the well-known covalent complexes with carbon monoxide, nitric oxide, *iso*cyanides, etc.[5]. The existence of such a phosphorus trifluoride–hæmoglobin compound has been established, providing further evidence for the covalent bonding ability of phosphorus trifluoride.

A solution of partially oxygenated human hæmoglobin was prepared (cf. ref. 5, p. 211) and portions of this solution were diluted with disodium hydrogen phosphate citric acid buffer solutions to give a hæmoglobin concentration about 1/200 that in whole blood. Hæmoglobin was then formed by reduction with sodium dithionate ($Na_2S_2O_4$), and portions of the solution were agitated with phosphorus trifluoride at various partial pressures in pure nitrogen. A pink colour, visually different from the colour of either oxyhæmoglobin or carbonmonoxyhæmoglobin, rapidly developed and the broad band of the hæmoglobin absorption spectrum centred around 560 mμ changed to give two sharp bands centred about 540 and 575 mμ; a hand spectroscope with a scale was used for detection. No change in colour or absorption bands was evident on addition of excess dithionate.

The formation of the phosphorus trifluoride–hæmoglobin complex is not critically dependent on the *p*H of the solution in the range 5·0–8·1. The complex is unstable, persisting for only a few minutes. In alkaline solutions, the rate of formation is slower and the rate of decomposition faster than in acid solutions, presumably due to the increase in the rate of hydrolysis of phosphorus trifluoride with increasing *p*H.

It has proved impossible to measure the absorption spectrum of the compound with any accuracy due to the rapid hydrolysis; but a rapid survey of the spectrum in the region from 520 to 590 mμ was made on a Beckman spectrophotometer. Comparison with the spectra of oxyhæmoglobin (peak maxima at 576–578 mμ and 540–542 mμ) and carbonmonoxyhæmoglobin (peak maxima at 568–572 mμ and 538–540 mμ) measured in the same conditions shows the close similarity of the phosphorus trifluoride hæmoglobin (peak maxima 574–577 mμ and 540–543 mμ) with the former. The intensity of the peaks appears to be similar and the α-peak is the sharper.

Again due to hydrolysis, estimation of the half-saturation pressure is impossible; however, the compound is readily formed with phosphorus trifluoride partial pressures of the order of 1 cm. mercury.

No evidence has been obtained for the formation of a hæmoglobin complex of nitrogen trifluoride, and the reported[6] cyanosis due to nitrogen trifluoride was probably due to impurities. The inability of nitrogen trifluoride to form a compound with hæmoglobin is probably due to the absence of vacant 2*d* orbitals in the nitrogen atom, so that there is no possibility of the π-bonding which occurs in the phosphorus trifluoride complexes, where there is a vacant 3*d* orbital in the phosphorus atom. The nitrogen trifluoride used in this work was kindly given by Prof. E. G. Rochow of Harvard University.

I am greatly indebted to Prof. Charles D. Coryell for his stimulating advice and for his contribution of samples of blood.

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Free Amino Groups of Collagen

Using the technique originated by Sanger[1] for the determination of end-groups in proteins by reaction with dinitrofluorbenzene, no free α-amino- or imino-groups have been detected in ox hide collagen[2], even when the equivalent of 2–3 gm. dinitrophenyl-collagen was placed on the silica gel columns.

After heating in water at 70° C., and treating with alkali, or urea, a small number of α-amino groups were found.

Since collagen contains a considerable amount of proline, the dinitrophenyl derivative of which is unstable to acid hydrolysis, special efforts were made to detect this derivative. Recovery of dinitrophenyl-proline added to collagen, and from salmine treated with dinitrofluorbenzene, indicates that proline would have detected it if it had been present to the extent of one end-group per unit of 1,500,000.

Failure to detect an end-group in collagen suggests three possibilities: (1) that the molecular weight is very large—greater than 1,500,000 if proline is an end-group, and of the order of 2,000,000 or more if some other amino-acid forms the terminal group; (2) that the molecule has a cyclic structure; or (3) that the end-group is inaccessible to dinitrofluorbenzene, or is masked in some way by combination with some other group, or with carbohydrate. There is insufficient evidence available at present to indicate which, if any, of these hypotheses is correct; but the following observations may be made. Average molecular weights of up to 250,000 have been reported for gelatin[3]; it is known that a small number of peptide bonds are broken in the conversion of collagen to gelatin, hence the molecular weight of collagen might well be several times this figure. There is only a small amount of carbohydrate in collagen; but it is perhaps of interest to note that the amount of chondroitin sulphate estimated to be present in this collagen from its hexosamine content and the intensity of spots due to glucosamine and chondrosamine on paper chromatograms[4] corresponds approximately to one molecule of chondroitin sulphate per unit of 80,000, that is, in roughly twice the minimum molecular weight (39,000) calculated from the amino-acid composition[2].

	α-Amino groups		Reactivity of lysine ε-amino groups with dinitrofluorbenzene (m.mol./100 gm.)
	(m.mol./100 gm.)	Weight containing one residue	
Collagen	No end-groups detected		17
Alkali-treated collagen			
Aspartic acid	0·07	1,400,000	
Glutamic acid	0·17	600,000	
Glycine	0·42	240,000	17
Phenylalanine	0·04	2,500,000	
Collagen dissolved in formic acid			
Aspartic acid	0·43	230,000	
Glutamic acid	0·15	700,000	
Glycine	0·65	150,000	—
Alanine	0·30	330,000	
Urea-treated collagen			
Aspartic acid	0·07	1,400,000	—
Heat-shrunk collagen			
Aspartic acid	0·15	700,000	
Glutamic acid	0·03 (approx.)	3,300,000	15
Gelatin (commercial)			
Aspartic acid	0·28	350,000	
Glutamic acid	0·12	830,000	17
Glycine	0·57	180,000	
Threonine	0·14	710,000	

Lysine content of collagen: 31 m.mol./100 gm.

In modified collagens, various end-groups were detected in small amounts (see table). With alkali-treated collagen, the small number of end-groups found does not represent the total number of peptide bonds broken, since about 5 per cent of the collagen was solubilized during the treatment, some as small peptides and some as comparatively large units[5]. These fractions are now being examined. Dispersion in formic acid has often been used as a method of obtaining 'soluble collagen'. The dinitrophenyl derivative of collagen treated with formic acid was soluble and resembled dinitrophenyl-gelatin rather than the other modified collagens.

Aspartic and glutamic acids were frequently found as end-groups of modified collagen, and it would appear that the peptide bonds involving the amino groups of these acids are particularly labile. Partridge[6,7] has also found that these acids are preferentially liberated in the partial hydrolysis of a number of proteins with weak acids.

The amounts of ε-dinitrophenyl-lysine isolated from all the collagens were appreciably less than the amounts corresponding to their lysine contents (see table). Even in gelatin, only about half the ε-amino groups of lysine reacted with dinitrofluorbenzene. Dinitrophenyl-hydroxylysine was also detected; evidence suggests that some of the side-chain amino groups of this amino-acid were also unreactive to dinitrofluorbenzene. Porter[8] also found that the ε-amino groups of a number of soluble proteins did not react with dinitrofluorbenzene, but that after denaturation all became available. This is not so with collagen, and there is some evidence that heat denaturation actually causes a slight decrease in the number of ε-amino groups reacting. With soluble proteins, denaturation is generally considered to cause unfolding of the polypeptide chains. Collagen is already in the extended form, and heat denaturation, which causes considerable shrinkage, probably involves folding of the chains, which may decrease the availability of amino groups.

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Direct Oxidation of Glucose by *Aerobacter* sp.

A PRECISE picture of a pathway of glucose metabolism existing in addition to the classical scheme proposed by Embden, Meyerhof, Parnas, Cori and many others is slowly emerging from experiments on carbohydrate metabolism[1–7]. This route, proceeding by way of 6-phosphogluconate and its derivatives, is called 'direct'. Some years ago, a study of aerobic and anaerobic acid formation with nitrogen-poor bacteria led one of us (J. D. L.) to suppose that, beside the classical respiration by triose phosphate dehydrogenase, our strain could equally well oxidize glucose by way of phosphogluconate, gluconate or a non-phosphorylative process[8].

We now report experiments demonstrating that in *Aerobacter* sp. a pathway of glucose metabolism exists in which gluconate (most probably as 6-phosphogluconate) and its derivatives are involved. (We

wish here to direct attention to the the fact that the strain, obtained from the Biochemical Laboratory, Helsinki, used by one of us (J. D. L.) in the earlier experiments in the latter and later in this Laboratory, was formerly erroneously called *E. coli*. It exhibits the properties of an *Aerobacter*.)

The bacteria were cultured in a synthetic medium containing dipotassium hydrogen phosphate, sodium chloride, magnesium and ammonium sulphate and carbohydrates or their derivatives (D-glucose, sodium D-gluconate, sodium 2-keto-D-gluconate, D-ribose). Various substances believed to partake in the direct metabolism of glucose were added to the centrifuged and washed bacteria, suspended in phosphate buffer, and the oxygen consumption was measured by means of the Warburg respirometer. No oxidation could be observed with the following substrates: sodium 5-keto-gluconate, D-arabinose, sodium D-arabonate, sodium D-ribonate. The fact that D-arabinose and D-ribonate are not oxidized is not in agreement with the original hypothesis by Dickens[3], although it might be asserted that the corresponding D-arabokinase and D-ribonokinase are absent from the cellular enzymic equipment.

The following substances were always fairly rapidly oxidized with or without an initial induction phase: D-glucose, sodium D-gluconate, sodium 2-keto-D-gluconate, D-ribose, L-arabinose, sodium D-glucuronate, D-xylose. The routes of breakdown of L-arabinose and D-xylose are obscure, suggesting the need for a study of the interconversion of pentoses by means of their phosphorylated derivatives, as in the well-known fructose-glucose-galactose transformations.

Since oxidative decomposition plays an important part in 'direct' glucose metabolism, we also investigated the influence of aerobic and anaerobic cultural conditions on the behaviour of the enzymic systems involved. Our experiments demonstrate that the enzyme systems which metabolize glucose by way of gluconate are not formed preferentially in aerobic culture conditions, but are also very actively present in anaerobically cultured bacteria. The cells grown aerobically oxidize their substrates faster, however, probably because of adaptive formation of cytochromes in presence of oxygen[9]. The oxidation of glucose never showed an initial lag phase and was independent of the substrate in the previous culture. Sodium D-glucuronate, D-xylose and L-arabinose were only oxidized after a considerable induction phase, indicating the formation of adaptive enzymes. The accompanying table shows the presence or absence of the initial lag phase in the oxidation of a substrate, according to the previous cultural conditions.

Substrate for respiration	Bacteria cultured on			
	D-Glucose	D-gluconate	2-Keto-D-gluconate	D-Ribose
D-Glucose	−	−	−	−
D-gluconate	+	−	+	+
2-Keto-D-gluconate	+	+	−	+
D-Ribose	+	+	+	−

+, Induction phase; −, no induction phase.

These results may be explained by the adaptive nature of the kinases for gluconate[7], 2-ketogluconate and ribose, while the enzymes catalysing the reactions glucose → glucose-6 phosphate → 6-phosphogluconate → 6-phospho-2-ketogluconate should be constitutive, since the latter substrates are oxidized at the same rate, once the adaptive kinase has been formed. The further breakdown of 6-phospho-2-ketogluconate and the reactions leading to 5-phosphoribose are by no means clear[9,10,11].

We hope to present in the near future a closer investigation of this and related problems. A full account of this work is to be published elsewhere.

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In vitro Fungistatic Action of Phenanthrolines against Pathogenic Fungi

Working with a diffusion technique described elsewhere[1], I found in August 1948 that a number of phenanthrolines had fungistatic properties, until then unknown. *o*-Phenanthroline, highly bacteriostatic for Gram-positive and Gram-negative bacteria, has a stronger growth-inhibiting effect against *Ctenomyces interdigitalis* (=*Trichophyton interdigitale*) than *p*- or *m*-phenanthroline. Alkylation of *o*-phenanthroline increased its fungistatic action. 2,9-Dimethyl-*o*-phenanthroline proved to be the most potent fungistatic agent of all phenanthrolines tested. Further alkylation or chlorination of the latter substance resulted in a reduction of its fungistatic action. 2,9-Dimethyl-*o*-phenanthroline was still effective in the test mentioned above when used in *M*/1600 solution. The fungistatic properties of this compound were not affected by adding serum to the medium, as happens with a number of fatty acids and their sodium salts. This substance also showed marked bacteriostatic properties against Gram-positive bacteria.

The spectrum of effectiveness of 2,9-dimethyl-*o*-phenanthroline includes numerous genera and species of fungi pathogenic for man and animals, such as *Ctenomyces interdigitalis*, *Trichophyton rubrum*, *T. tonsurans*, *T. schönleini*, *Sabouraudites audouini* (= *Microsporum audouini*), *S. canis*, *Epidermophyton floccosum*, *Candida* species, *Nocardia* species, *Hormodendrum pedrosoi*, *H. compactum*, *Sporotrichum schenckii*, *Piedraia sarmentoi*, *Phialophora verrucosa*, etc.

Recently, *Aleurisma tulanense* (= *Blastomyces dermatitidis*), freshly isolated from a case of cutaneous North American blastomycosis, was tested against 2,9-dimethyl-*o*-phenanthroline. A dilution method described by Kolmer and Boerner[2] was used for this

purpose. This fungus did not grow on a medium containing Sabouraud glucose agar, 'Difco' and 10 per cent serum with 0·002 per cent 2,9-dimethyl-o-phenanthroline. Growth was strongly inhibited by this substance in concentrations ranging from 0·001 to 0·0005 per cent. Normal growth occurred if the medium contained less than 0·0005 per cent of the substance.

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Effect of Oxidized *d*-Limonene on Micro-organisms

DURING our studies on microbiological problems in the citrus industry, we found it necessary to study the effect of essential oils on micro-organisms. As a first step in this study, we investigated in a synthetic medium the influence of *d*-limonene, which constitutes more than 90 per cent of the orange essential oil, on micro-organisms normally present on the surface of oranges.

It was shown in this way that *d*-limonene, freshly distilled over sodium, has no inhibitive action on the micro-organisms tested (a strain of *Sacar. elipsoideus*, *Wilia hansenula*, *Oidium lactis*) when added to the synthetic medium. However, the vapours of this limonene exhibit a bacteriostatic effect.

When exposed to air, *d*-limonene reveals inhibitive properties, which increase with the duration of exposure. Also, when samples of the oxidized limonene are tested for the presence of peroxides by the potassium iodide method, iodine is liberated and by titration an increase of peroxide formation may be shown.

Quantitative estimation of the inhibition by Hinshelwood's method[1] has revealed that this action is marked only by shifting the time of the lag phase, without any influence on the logarithmic growth phase and the number of the total population. When plotting the lag time against the increased doses of an oxidized *d*-limonene, an adsorption isotherm curve is obtained, similar to those obtained by Hinshelwood. Samples of *d*-limonene, taken at different times of exposure to air, give a set of such curves with the point of lethal dose decreasing with increasing time of oxidation.

The oxidized *d*-limonene, in the aqueous nutrient medium, however, loses its inhibitive properties on keeping. This decrease of inhibition is enhanced by the presence of *l*-ascorbic acid in the medium.

Steam distillation of oxidized *d*-limonene in presence of sodium hydroxide also destroys its inhibitive properties. Neither the distillate nor the resinous viscous residue added in adequate doses to the synthetic medium shows any inhibition of the micro-organisms tested.

Recent advances in organic chemistry[2] show that the fixation of an oxygen molecule from air in *d*-limonene will take place by forming a peroxide bond. This oxidation can be considered as an 'initiation reaction', which will catalyse a second reaction, namely, a polymerization of the activated terpen radicals. Hence, we may assume that the first reaction is responsible for the appearance of the inhibitive properties of limonene exposed to air. This accords with the generally known toxic properties of peroxides or epoxides. (However, the possibility that the second reaction may influence the specific toxicity of any peroxide formed cannot be excluded.)

There is a lack of precise chemical–physical data as to the mechanisms of the two reactions. When in our experiments the oxidation of *d*-limonene was carried out in different physical conditions, quantitative estimation of the reaction showed a change in the value of the parameters of the adsorption isotherms. A more detailed account of this work will be published elsewhere.

The fact that the oxidation is catalysed by light and chlorophyll[3] suggests that the reaction is possibly of biological importance, and experiments in this direction are under way.

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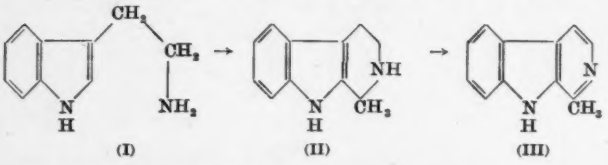
Isolation of Tetrahydroharman from *Petalostyles labicheoides*

IN the course of a comprehensive study of the alkaloids in Australian Leguminosæ, the examination of *Petalostyles labicheoides* was undertaken. This erect and bushy shrub grows to a height of several feet, and is found mainly in northern New South Wales and in Queensland. Alkaloids were detected in this plant in the course of the extensive field tests carried out by Mr. L. J. Webb[1], who kindly arranged for a quantity of the plant to be supplied for more intensive investigation.

The finely ground and dried plant was first intracted with chloroform to remove various colouring matters, after which the alkaloid was extracted with methanol. Concentration of the extract gave a thick syrup which was taken up in 1 per cent hydrochloric acid. The acid solution was basified, and the precipitated alkaloid extracted with ether. (The ether-insoluble material probably contained another (unstable) alkaloid, which, however, has so far resisted all attempts at purification.) The crude crystalline material obtained on evaporation was dissolved in anhydrous ether and purified by chromatography on alumina. The pure alkaloid formed very pale yellow prisms or needles, of melting point 178–180° (found: C, 77·5; H, 7·7; calc. for $C_{12}H_{14}N_2$: C, 77·4; H, 7·6 per cent). The melting point, analysis and ultra-violet absorption spectrum, the last kindly determined by Mr. R. S. Pearce (maxima at 2255 A., log ε, 4·57; 2830 A., log ε, 3·90; and 2910 A., log ε, 3·82), indicated that the alkaloid was tetrahydroharman (II, melting point in the literature, 179–180° [2]). The benzoyl derivative first separated from ether as colourless crystals, melting point 165–167° (in the literature, 168–169°), but on recrystallization from 50 per cent alcohol it formed long needles of melting point 194–195° (found: C, 78·55; H, 6·0; calc. for $C_{19}H_{16}N_2O$: C, 78·25; H, 5·8 per cent). This was evidently a dimorphic form. The identity of the alkaloid was confirmed by the preparation of the hydrochloride, melting point

(decomp.) 265° (in the literature, 267° (decomp.)), and by a mixed melting point comparison with an authentic synthetic specimen kindly presented by Dr. R. H. F. Manske. Finally, the ultra-violet absorption spectrum of the natural product coincided exactly with that of the synthetic material.



(I) (II) (III)

Tetrahydroharman (II) does not seem to have been obtained previously from natural sources, and this proof of its occurrence in Nature is of interest in connexion with studies of the biogenesis of alkaloids. It has often been suggested[2], for example, that harman (III) and related β-carboline alkaloids, are synthesized in the plant from tryptamine (I), or tryptophan, by condensation with acetaldehyde to give (II), and subsequent dehydrogenation to (III). Tryptamine (I) has already been shown[4] to occur in several species of the genus *Acacia* (Leguminosæ), and G. Hahn and H. Ludewig[5] have demonstrated that tryptamine readily condenses with acetaldehyde *in vitro* and under 'physiological' conditions of temperature and *p*H. Harman (III) has, of course, been isolated from several plants[6], and the present isolation of tetrahydroharman (II) from a natural source completes the series and supports the speculations of Robinson and others[3] in a very satisfactory way.

Note added on July 19. It has recently been announced[7] that racemic tetrahydroharman has also been isolated from *Elæagnus augustifolia*.

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Alkaline Decomposition of Amino-acids

In the course of an examination of the amino-acid composition of soil hydrolysates by the paper chromatography technique, it was noticed that alkaline hydrolysates of soil contained greater amounts of α-amino-*n*-butyric acid than did acid hydrolysates[1]. Further work indicated that alkaline hydrolysates also contained greater amounts of glycine. These results suggested that, under the conditions commonly employed for the hydrolysis of proteins with alkali, glycine and α-amino-*n*-butyric acid are formed by decomposition of other amino-acids. Paper chromatographic examination of acid (6 *N* hydrochloric acid) and alkaline (5 *N* sodium hydroxide) hydrolysates of casein supported this, since α-amino-*n*-butyric acid was found in the alkaline, but not in the acid, hydrolysate, and the glycine spot on chromatograms of the alkaline hydrolysate was distinctly stronger than the corresponding spot on comparable chromatograms of the acid hydrolysate.

These findings led to a study of the effect of hot sodium and barium hydroxides on various amino-acids. Results so far obtained have shown that, under the conditions generally used for hydrolysis of proteins with alkali, threonine yields glycine and α-amino-*n*-butyric acid, serine yields glycine and alanine, and cysteine and cystine yield alanine. An attempt is now being made to follow these decompositions quantitatively. Preliminary results indicate that, after treatment of threonine with 5 *N* sodium hydroxide in a sealed tube at 105° C. for 24 hr., about 1–3 per cent of the original threonine nitrogen is present as α-amino-*n*-butyric acid and 60–70 per cent as glycine.

Full details of this work will be published later.

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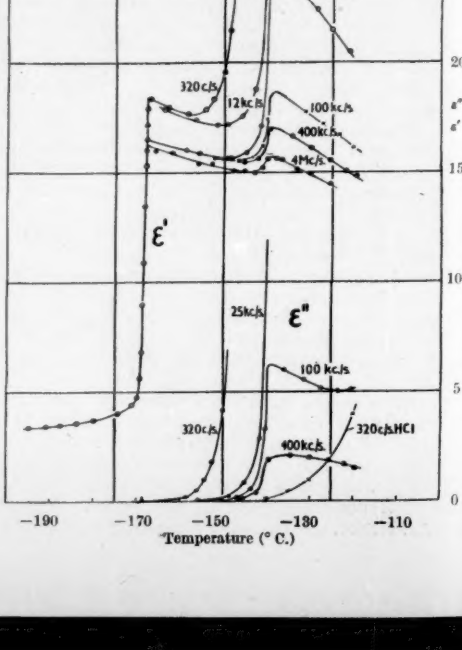
Dielectric Properties of a Sample of Deuterium Chloride containing an Impurity

Following a fairly extensive study of the dielectric properties of solid hydrogen chloride in this Laboratory[1], it was proposed to investigate the deuterated form. While hydrogen chloride was prepared by action of strong sulphuric acid on sodium chloride, deuterium chloride was obtained by dropping heavy water on thionyl chloride, the other product of the reaction being sulphur dioxide.



The first sample of deuterium chloride studied showed anomalous properties when compared with hydrogen chloride, due evidently to the presence of an impurity. The variation of ε' and ε'' with temperature for this sample are shown in the accompanying graph. As can be seen, the impurity causes a further transition point of first order to appear at $-140{\cdot}5°$ C., that is, some 28° higher than the transition point corresponding to pure deuterium chloride, which, judging by the steepness of the rise in ε' and the value of the transition temperature itself ($-168{\cdot}5°$ C.) does not appear to be affected by the presence of the impurity. Repeated distillation progressively reduced the magnitude of the effect, without noticeably changing the temperature of either transition. The effect decreases with increasing frequency, so that it is scarcely observable at 4 Mc./s. A twenty- to thirty-fold increase in the D.C. conductivity was also observed at the higher transition.

The properties of solid sulphur dioxide have not been previously investigated. As it was suspected that this substance was in fact the impurity, ε' and ε'' were measured at various frequencies between 80 c./s. and 6 Mc./s. over a temperature range from $-195°$ C. to its melting-point ($-10{\cdot}0°$ C.). However, sulphur dioxide does not show any dispersion or transition effect in this frequency- and temperature-range.

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Nature of the Transition in Carbon Tetrabromide

MANY transitions in solids have in the past been regarded as being due to, or accompanied by, the onset of ionic or molecular rotation. There is, however, little convincing evidence that ions or molecules can rotate *freely* in crystal lattices. The balance of available data is against this interpretation of transitions, though it is clear from studies of the dielectric constant that, at many transitions in molecular solids with polar molecules, the molecules acquire much greater orientational freedom on passing into the high-temperature form.

In principle, information about the molecular or ionic motion can be obtained from the values of c_v, which can be derived from experimental measurements of c_p, the coefficient of expansion (α), and the isothermal compressibility (β), using the well-known formula $c_p - c_v = T\alpha^2V/\beta$. This method has been applied to the transition (λ-point) in ammonium chloride by Lawson[1]. By combining his measurements of β with existing values of c_p and α, he showed that, above the transition, c_v is sufficiently near $9R$ cal./mole to enable one to say with certainty that the ammonium ions do not, in fact, rotate above the λ-point, but rather continue to undergo torsional oscillations in three degrees of freedom which are approximately simple harmonic. This conclusion has since been confirmed in other ways[2,3].

We have applied this method to the first-order transition in carbon tetrabromide at $46{\cdot}9°$ C. This transition gives rise to a much more symmetrical high-temperature form and is accompanied by a considerable increase of entropy. A number of transitions in solids composed of molecules of high symmetry are probably similar in these respects. It is therefore of interest that our results definitely show that the carbon tetrabromide molecules do not rotate freely in the high-temperature form.

The isothermal compressibility β was measured directly at three temperatures by applying pressures between 15 and 50 atmospheres, which are sufficiently low for the figures so obtained to be regarded as the limiting values at one atmosphere. We have also determined c_p above and below the transition and the heat of transition (using an adiabatic calorimeter), and α. From the values of c_v calculated from these results, we have deducted $c_{v(\text{int})}$, the contribution from the intramolecular vibrations, to give $c_{v(\text{res})}$, the contribution from the lattice vibrations and the torsional oscillations or rotation of the molecules. The results are summarized in Table 1; v is the specific volume.

Table 1

t(° C.)	v	$\alpha\times10^4$	$\beta\times10^6$ atm.$^{-1}$	c_p	c_v	$c_{v(\text{int})}$	$c_{v(\text{res})}$
0	0·2836	3·61	24·5	28·25	24·95	13·23	11·7
37·7	0·2882	5·05	29·9	31·70	25·55	14·05	11·5
55·3	0·3119	5·82	38·7	33·0	25·8	14·33	11·5

It is difficult to assess the uncertainty in the values of $c_{v(\text{res})}$ arising from the accumulation of experimental errors in the quantities used in calculating them, but it should not exceed $\pm 0{\cdot}5$ cal./mole. Since at the temperatures concerned the contribution to $c_{v(\text{res})}$ from the lattice vibrations must be very nearly $3R$ cal./mole, the figures definitely exclude free molecular rotation in the high-temperature form, which would require $c_{v(\text{res})}$ to be $9/2\ R$ cal./mole. On the other hand, the values of $c_{v(\text{res})}$ are so near $6\ R\ (= 11{\cdot}9)$ cal./mole that it is probable that both above and below the transition the molecules undergo torsional oscillations in three degrees of freedom with approximately simple harmonic motion. From calculations of the thermodynamic properties of restricted rotators, our results could also mean that the rotation of the molecules is impeded by a barrier of such a height that in the temperature-range studied the contribution to $c_{v(\text{res})}$ from the torsional oscillations has roughly the maximum possible value. It would be interesting to know how $c_{v(\text{res})}$ changes as the temperature is further increased; but unfortunately the range between the transition point and the melting point is only about 40°. But in any event the conclusions that the molecules do not rotate *freely* in the high-temperature form, and that there is essentially no change at the transition point in the type of motion they undergo, seem inescapable.

The figure we have obtained for the heat of transition is rather different from that reported by Frederick and Hildebrand[4]; but it gives a value for the entropy of transition which is almost the same as that for the transition in carbon tetrachloride. In Table 2 are given values for the entropies of transition and fusion, and also the ratio T_{tr}/T_m (that is, of the transition temperature to the melting point) for carbon tetrafluoride, tetrachloride, and tetrabromide. The close similarity between the figures for the three substances strongly suggests that the nature of the transitions in them is the same, and that the conclusions we have reached about the tetrabromide are true also of the tetrafluoride and tetrachloride. A further similarity between the three transitions is that at none of them is there a significant change in the heat capacity at constant *pressure*.

Table 2

	CF_4	CCl_4	CBr_4
T_{tr}/T_m	0·852	0·901	0·881
ΔS_{trans}	4·64	4·86	4·98
ΔS_{fusion}	1·87	2·40	2·60

Finally, we may add that we have also measured the coefficient of expansion and compressibility of ammonium chloride above and below the λ-point (− 30·5°). Our results lead to values of c_v of 18·5 cal./mole at − 44·55°, and 18·7 cal./mole at − 19·31° and 0°. These figures fit in very well with those reported by Lawson[1], and confirm the conclusion he reached about the nature of the transition in this substance.

A full account of this work will be published elsewhere.

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Solid Phase Determinations in the System Aluminium Sulphate/Sulphuric Acid/Water using Tracer Technique

In the system aluminium sulphate/sulphuric acid/water, the solid phase in the range 50–60 per cent sulphuric acid has been reported to be either $Al_2(SO_4)_3.9H_2O$ [1,2] or $Al_2(SO_4)_3.10H_2O$ [3] at temperatures between 20° and 60°, the composition of this solid being deduced by the Schreinemakers[4] method of tie-line convergence. However, in view of (*a*) the high molecular weight of aluminium sulphate compared with sulphuric acid and water, (*b*) the relative position in the equilateral triangle of the solubility curve, (*c*) inaccuracy in the position of the solution and moist solid points owing to the well-known difficulty of determining sulphuric acid in presence of aluminium sulphate, the published tie-lines show equally good convergence at points representing the 8, 9 or 10 hydrates or the 1 : 1 acid sulphate with eleven to thirteen molecules of water of crystallization.

This and similar cases[5] of ambiguity may be resolved by adding to the solubility mixture a suitable indicator substance which remains throughout in the liquid phase. Provided this indicator does not significantly alter the phase equilibrium and can be determined accurately in trace quantities, then the composition of the moist solid phase can be corrected for the contaminating liquid phase. Radioactive cæsium sulphate has been found to fulfil these severe conditions very well: only 0·05 c.c. of 0·045 per cent aqueous solution of approximately 15 μC. activity was required in a 50-gm. solubility mixture. This was not added until after the ternary mixture had been brought to equilibrium at 30° to avoid any co-precipitation of the tracer with the solid phase. The saturated solution and moist solid phase after convenient dilution were analysed for aluminium by precipitation with 8-hydroxyquinoline, for sulphuric acid by an accurate titration procedure, while counts were carried out in Type *M*6 Geiger–Müller liquid counters. Self-absorption errors were negligible because the counted solutions, after dilution with an equal volume of water, gave exactly half the original count. The solid phase was shown in this way to have the composition 51·4 per cent $Al_2(SO_4)_3$, 15·9 per cent H_2SO_4, 32·7 per cent H_2O, and must therefore be $Al_2(SO_4)_3.H_2SO_4.12H_2O$. This composition has been confirmed by using trace quantities of manganous sulphate as indicator, the manganese being determined colorimetrically as permanganate. The composition in this case was 51·5/15·1/33·4. It is surprising that this acid sulphate can be isolated in the pure state by simple filtration and thorough washing with 'Analar' acetone under anhydrous conditions, the composition of the dry 50° product being 51·4/15·1/33·5.

Other acid sulphates of composition 1/1/8 (two forms) and 1/1/2 have been encountered in this system, and full details will be published shortly elsewhere in collaboration with Prof. H. Bassett.

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Electrical Conductivity and Magnetic Susceptibility of Ovalene

Ovalene ($C_{32}H_{14}$) has the most compact configuration of rings among the condensed aromatic compounds which have so far been obtained. From this point of view, it is of interest to know the electrical and magnetic properties to be attributed to the π-electrons of this molecule.

Ovalene was synthesized by the method of Clar[1] with modifications, and purified by repeated sublimation *in vacuo*. The measurement of the electrical conductivity as well as the magnetic susceptibility was carried out with a powder specimen. The electrical conductivity σ can be expressed as $\sigma = \sigma_0 \exp(-\Delta\varepsilon/2kT)$, in the same manner as for the other condensed aromatic compounds[2]. The values of σ at 15° C. and Δε were found to be $4{\cdot}4 \times 10^{-16}$ ohm^{-1}.cm.$^{-1}$ and 1·13 eV. respectively. The electrical conductivity of ovalene is less than that of violanthrone or *iso*violanthrone which were reported in the previous paper. In a series of measurements on a number of the condensed aromatic compounds, we have found that the electrical conductivity depends mainly on the number of π-electrons alone, and not on the configuration of the rings. On the other hand, the magnetic susceptibility is largely influenced by the shape of the molecule.

Molecular susceptibility was found to be $\chi_M = -(353{\cdot}8 \pm 2{\cdot}8) \times 10^{-6}$, by Gouy's method. $\chi_M = \frac{1}{3}(K_1 + K_2 + K_3)$ can be assumed, where K_1 and K_2 are the molecular susceptibilities along two directions in the plane of the rings and K_3 is that perpendicular to the plane. It can also be assumed that $K_1 = K_2 = \Sigma\chi(C=) + \Sigma\chi(H)$, and calculated from Pascal's constants on the basis of spherical symmetry. H. Shiba and G. Hazato[3] have shown that it is a good approximation to put $\chi(C=) = \chi(C) + \frac{1}{3}\lambda$(diethylene

linkage) $= -3{\cdot}36 \times 10^{-6}$, for this purpose. From these assumptions, the magnetic anistropy $\Delta K = K_3 - K_1$ was found to be $-615{\cdot}9 \times 10^{-6}$ for ovalene. This is a very high value. The contribution of each π-electron to the magnetic anisotropy can be expressed, conventionally, by the classical theory, $\Delta K = -(Ne^2/4mc^2)\sum_{\pi}\bar{r}^2$, where $\bar{r}$ is the mean radius of a circular orbit of a π-electron. For ovalene, $\bar{r}$ is calculated to be 2·12 A. This is also a high value, when it is remembered that $\bar{r}$ is 1·44 A. for benzene, 1·57 A. for naphthalene, 1·63 A. for anthracene and 1·86 A. for pyrene, where these values were calculated by the same method as for ovalene from specific susceptibility data in the literature, which do not differ seriously from the values obtained with single crystals[4].

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Physical Basis of Internal Calorimetry

The technique of 'internal calorimetry', a development of Gibbs's 'heated thermocouple' method[1], was devised for the measurement of blood flow in living tissues. The instrument consists of a small constantan filament connected to a source of electrical potential, variable at will. An attached thermocouple records the filament temperature. The energy required to maintain thermal equilibrium with the instrument embedded in the experimental material is recorded electrically. Its relation to blood flow has already been described[2]; our present concern, however, is with the non-circulatory heat losses from the filament.

With a recorder embedded in a gel—5 per cent gelatine in water—and heated 1° C. above ambient temperature, temperatures were measured thermoelectrically along a line perpendicular to the filament and also back along the leads. Temperatures were less than 0·01° C. in excess of the ambient temperature at a point in the gel 5 mm. from the filament and at a point on the wire distant 1 cm. from the filament.

It can be shown mathematically[3] that, with an electrically heated spherical source of heat in an infinite mass of material, a steady state is approached in which the relation between heat production and heat loss is represented by the equation:

$$I^2R = 4K.\pi.r\theta$$

(where K is thermal conductivity of the substance, r is radius of sphere, θ is temperature elevation of sphere, I is heating current and R is heating filament resistance). Where θ, r and R are fixed, I^2/K is thus constant.

That a similar relation may be applied to the present work was demonstrated using a standard instrument to record in air, chloroform, 'Vaseline', glycerine, water and mercury. Temperature was carefully controlled and convection errors eliminated by methods similar to those of Read and Lloyd[4]. In each case, the value of I^2 for $\theta = 1°$ C. was determined. Taking the values of K as given in the "International Critical Tables", the value of I^2/K was obtained for each substance and found to be virtually constant at $14{\cdot}0 \times 10^4$ ($\pm$ 1 per cent). This ceased to be true if the depth of insertion or the bulk of fluid was not sufficient. The limits determined in 5 per cent gelatine, however, were 1 cm. depth of insertion and 5 mm. of substance surrounding the thermocouple.

It was thus shown, under these experimental conditions, that with θ constant, $I^2R \propto K$. In further experiments where K was constant, the relation between θ and I^2R was investigated and found to be linear except when θ was so large that the limiting conditions were exceeded.

These findings facilitate the standardization of blood-flow recorders in a manner to be described elsewhere. Moreover, they show that the method of 'internal calorimetry' may be used as a simple, quick means of measuring thermal conductivities, particularly in animal tissues.

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Effect of Tension on Water Absorption by Hair

It seems to be generally assumed that the application of tensile stress to a textile fibre should *reduce* the amount of absorbed water in equilibrium with water vapour in the atmosphere at a given value of the relative humidity[1]. This assumption would appear to be substantiated by the recent work of White and Stam[2] on human hair, in which a substantially reversible reduction of water content amounting to 50 per cent was found to occur on the application of a tensile stress of approximately 120 kgm./cm.^{2}.

On the other hand, for vulcanized rubber swollen in organic solvents, the equilibrium solvent concentration is *increased* by tensile stresses and reduced by compressive stresses[3]. This result is well established experimentally, and is in quantitative agreement with the statistical theory of the swollen molecular network[4,5].

In view of the opposite nature of these reported effects for fibres and for rubber, for which no immediate explanation is apparent, it seemed worth while to re-examine the question of the absorption of water by fibres under stress.

A general theory of the phenomenon may be derived by a simple extension of the usual thermodynamic treatment of swelling pressures. From such a theory Barkas[6] has obtained a relation which, in the case of a simple tensile stress, may be written:

$$\varepsilon_X\, dX = -v\, dp, \qquad (1)$$

where ε_X is the fractional increment of length in the direction of the stress X due to the absorption of 1 gm. of liquid, and v is the specific volume of the

vapour at the pressure p. This equation relates the change dp in vapour pressure at equilibrium to the change dX in the stress; the corresponding change in water content, at constant vapour pressure, is then readily obtained from the vapour-pressure isotherm. It is seen from (1) that if s_X is positive, that is, if liquid absorption is accompanied by an increase of length in the direction of the stress, then dp is negative. This means that the vapour pressure (at constant liquid content) is lowered, so that at constant vapour pressure the liquid absorption is increased. This result should certainly apply in the case of hair, for which s_X is known to be positive.

In White and Stam's work the water content was determined indirectly from the measured dimensional changes of the fibre. I have repeated their experiments, using horsehair, which on account of its larger diameter permitted the water absorption to be determined more directly by weighing. Eight hairs, having a total length of 3·6 metres, were stretched by means of springs on a frame which was suspended from the arm of a balance in a temperature- and humidity-controlled vessel, the temperature being 24·0° C. and the relative humidity 75·5 per cent. The procedure was to weigh the assembly with the stress alternately applied and removed, time being allowed after each change for the attainment of equilibrium. The results are given below, each figure being the mean of four or five readings.

Tension per single hair (gm.)	(kgm./cm.²)	Total wt. of hair (gm.)	Wt. increase on stressing (% of dry weight)
149	460	$0{\cdot}1519_0$	0·38
0	0	$0{\cdot}1514_2$	
82	250	$0{\cdot}1515_8$	0·17
0	0	$0{\cdot}1513_4$	

The change in water content on applying the stress, though small, was consistent and reproducible. It was in the opposite direction to that found by White and Stam. To within the experimental error, the effect was proportional to the stress, the weight increments being in the ratio 2·2 to 1 for stresses in the ratio 1·8 to 1.

An estimate of the theoretical increment of water absorption may be made by using White and Stam's data for the longitudinal swelling. For 75 per cent relative humidity, the value obtained for s_X is 0·028 cm./gm. For a stress increase of 460 kgm./cm.², equation (1) then gives a change in relative vapour pressure (dp/p_0) of 0·0069. From Chamberlain and Speakman's vapour pressure curve[7], the corresponding change in water content (referred to the dry weight) is 0·23 per cent, compared with the experimental figure of 0·38 per cent. While the quantitative significance of this comparison is questionable, in view of the experimental uncertainty, there seems no doubt that the theory gives a satisfactory interpretation of the phenomenon, at least in order of magnitude.

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Ultrasonic Velocity in Potassium Chloride Solutions in the Region of their Negative Viscosities

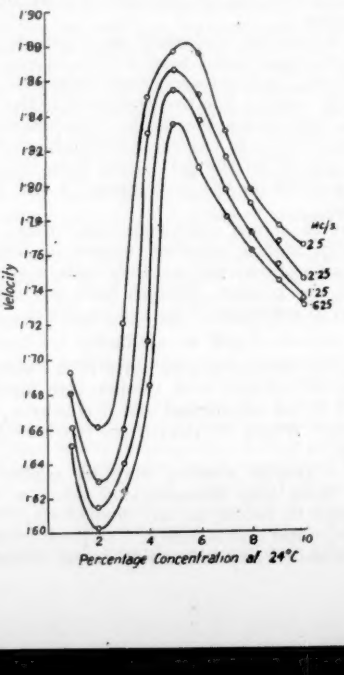
It was observed by Poiseuille[1], Hubener[2], Sprüng[3], Slotte[4] and others, that when substances like ammonium iodide, potassium chloride, etc., are dissolved in water, the viscosity of water is lowered. This phenomenon has since been known as 'negative viscosity'. The compressibility of aqueous solutions of electrolytes has been studied by Gibson[5], Falkenhagen and Bachem[6], Szalay[7] and others, and they have derived expressions for the relationship between the concentration of electrolyte solutions and their compressibilities. The existing data show that the compressibility continuously decreases as the concentration of electrolytes is increased. But these observations are confined to the positive region of viscosity. In the present communication we record our observations on the ultrasonic velocity in potassium chloride at low concentrations at 24°. The ultrasonic energy was obtained from a quartz disk and was converted into electrical energy by a similar quartz crystal for detection. The apparatus has been described elsewhere[8]. The slab can be rotated, resulting in a variation in the amplitude of the transmitted energy as recorded on the oscillograph screen. The minimum in the energy is due to the total reflexion of the transmitted energy, as the angle of refraction in the solid is greater than that of incidence. The refractive index at the discontinuity is:

$$n = \sin\theta_l / \sin\theta_s = V_l / V_s,$$

where θ_l and θ_s are the angles that the wave-train makes with the normal in the solid and the liquid respectively. V_s is the velocity in the solid, which can be determined in advance by using a liquid with known velocity. At total reflexion of the waves, due to the rotation of the slab,

$$V_0 = V_s \sin\theta_l, \quad \text{since } \theta_s = 90°.$$

A knowledge of θ enables us to determine the velocity in the liquid.



The velocity has been determined for four frequencies, as outlined in the accompanying table.

ULTRASONIC VELOCITIES OF POTASSIUM CHLORIDE SOLUTIONS AT 24° C.

Percentage of potass. chloride	2·5 Mc./s.		2·25 Mc./s.		1·25 Mc./s.		0·625 Mc./s.	
	θ_l	V_l	θ_l	V_l	θ_l	V_l	θ_l	V_l
1	57·0°	1·692	57·2°	1·680	56·1°	1·660	55·6°	1·650
2	57·1°	1·659	54·6°	1·629	53·8°	1·615	53·2°	1·602
3	59·4°	1·720	56·1°	1·660	55·1°	1·640	54·3°	1·625
4	57·4°	1·684	58·8°	1·710	66·2°	1·830	67·7°	1·849
5	69·7°	1·876	68·9°	1·866	67·9°	1·853	66·5°	1·834
6	69·6°	1·875	67·7°	1·850	66·7°	1·836	64·7°	1·808
7	66·2°	1·830	65·1°	1·814	63·9°	1·796	62·9°	1·780
8	63·9°	1·795	63·4°	1·788	62·4°	1·772	61·7°	1·760
9	62·7°	1·776	62·1°	1·768	61·3°	1·754	60·7°	1·744
10	61·8°	1·763	60·7°	1·744	60·0°	1·732	59·7°	1·726

It will be seen from the results in the table and from the graph that the ultrasonic velocities show anomalous behaviour in the region of negative viscosity (1–6 per cent solution); hence, it may be useful to correlate the ultrasonic velocity data, or in other words the compressibility data, of electrolyte solutions with the negative viscosity.

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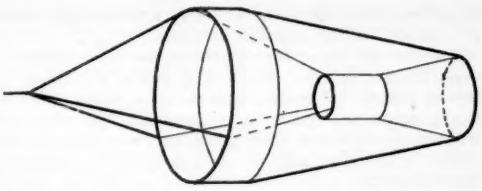
A High-speed Tow-net

IN order to investigate the changes in the distribution of young fish in the Clyde sea area it was necessary to obtain on each of a series of dates numerous samples of the population over a large area. To cover this area it was necessary for the research vessel to travel at full speed for as much as possible of the time available. This precluded the use of conventional tow-nets or trawls at set stations. Further, an apparatus like the Hardy plankton recorder would filter too small a volume of water to catch a significant number of young fish. Sheard[1] has described a net which appeared to be of the type required, in which the bucket is dispensed with and the tail of the net fliped (turned in on itself).

An ordinary plankton net was modified on this plan. The dimensions of the original net were: diameter of mouth 46 cm., calico collar 15 cm. long, silk (26 meshes per inch) 94 cm. long, bucket-sleeve 12 cm. in diameter and 17 cm. long. A metal ring was sewn into the end of the sleeve and three toggled bridles 42 cm. long attached to this ring. The tail of the net was fliped and the three toggles passed through the eye-splices of the main bridles of the net, as shown in the diagram. The bridles were shackled to a spring hank rove a fathom and a half above a cable depressor[2], on the trawl warp, and trials showed that it could be towed successfully at speeds of at least 7 knots. The general performance of the gear was found to be very satisfactory; there was



no inclination to yaw and no frontal wave was observed.

By towing two such nets alternately, for four miles at a time, 5 m. below the surface, it has been possible to obtain samples continuously along the course of a 68-mile cruise. At the time of writing, each of the two nets employed has been towed for more than 160 miles without signs of undue strain. The catches which have already been obtained and analysed contained thirty-seven species, including up to 250,000 *Calanus* and 3,000 fish eggs per haul, sprats of up to 9 cm. in length and a wide variety of post-larval fish. Although more of these organisms were damaged than is usual in a normal tow-net catch, all but a few were easily identifiable, and indeed the majority of the catch was still alive when brought on board. Tests of the efficiency of the nets are in hand, and preliminary results indicate that their catching power is closely comparable with that of a tow-net of conventional design. Nets of various diameters and mesh sizes are also being tested, and the possibility of fishing at greater depths investigated.

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Beet Yellows Virus

SEVERAL plant viruses have been found to occur as elongated particles of variable length and 10–15 mμ in width. Leyon[1] has published electron micrographs showing such rod-like particles with a width of about 10 mμ in sap from plants infected with beet yellows virus and in the specific precipitates produced by mixing the sap with its antiserum. We have also found rods in these two kinds of preparation. They do not occur in sap from healthy beet plants, and by analogy with other viruses which have been purified it could readily be assumed that the rods are the virus particles themselves. There are, however, other factors which make this assumption less tenable and suggest that the rods are not the only anomalous component in sap from infected plants.

With the appropriate antiserum, clarified sap from sugar beet plants infected with beet yellows virus gives specific precipitates that appear to be of the somatic type. Their precise character is difficult to determine when working with unfractionated material; but the general behaviour in precipitin tests resembles that of viruses with spherical rather than rod-shaped particles. Precipitates are obtained up to dilutions of 1/64, which by analogy with bushy stunt virus would suggest a specific antigen of concentration about 100 mgm./l.[2,3]. By contrast, only a few rod-like particles can be seen in electron microscope mounts made from clarified sap; and although the concentration cannot be determined accurately, it seems unlikely that it exceeds 1 mgm./l.[3]. It appears

therefore, that the rods can only amount to a small proportion of the specific antigen.

Further evidence for this view has been given by experiments on the effect of freezing sap from infected plants. Freezing had no detectable effect on the precipitin titre with antiserum; but after this treatment no rod-shaped particles have been found, either in clarified sap or in resuspended antiserum precipitates.

The evidence suggests that sap from infected plants contains at least two kinds of specific particles. One of these is the rod which can be seen with the electron microscope. The other probably occurs in much higher concentration; its size and shape are so far unknown; but the character of the precipitin reaction suggests that it may be spherical. Clarified sap from healthy sugar beet plants contains large quantities of spherical particles resolvable with the electron microscope[3], and it may be that the second antigen component resembles these. Alternatively, it may have particles too small to be resolved in existing electron microscopes.

The relationship between the components is unknown. Possibly the rods are an alternative form of the spherical particles, a phenomenon known with some other viruses, or perhaps the two components are quite distinct, one being the infective particle and the other a product of the disease.

H. L. Nixon
M. A. Watson

Rothamsted Experimental Station,
Harpenden, Herts.
May 9.

[1] Leyon, H., *Arkiv Kemi*, **3**, 10 (1951).
[2] Kleczkowski, A., and Watson, M. A., *Ann. App. Biol.*, **36**, 320 (1944).
[3] Bawden, F. C., and Nixon, H. L., *J. Gen. Microbiol.*, **5**, 104 (1951).

A Rare Alga from Stonehenge

During a brief stay in England last year, towards the end of June a visit was paid to Stonehenge. It was noticed that several small holes in one of the fallen stones near the centre of the Circle contained green-coloured water, and since I am particularly interested in the flora of such small rain-water pools, permission to take samples was sought and readily granted. Water was spooned up, concentrated in a small freshwater plankton collecting net, and small quantities of the concentrate transferred to comparatively large jars. The following evening, on reaching my headquarters in Cheltenham, the samples were examined and most surprisingly proved to be very rich, active and nearly pure unialgal growths of *Hæmatococcus drœbakensis* Wollenweber[1]. I believed then that this alga was known only from pools in granite on a small island near Drōbak in Norway; I have learnt since that there is one doubtful record from Wales.

This pretty little alga is most distinctive, bright green, with two pyrenoids placed symmetrically at opposite poles of the protoplast, across the centre of which is a clear, colourless zone; when grown in a rich nutrient solution, however, the latter is more or less completely obliterated by the extension of the chloroplast, while the whole protoplast becomes densely granular and much darker in colour.

Unlike the ubiquitous *Hæmatococcus lacustris*, in which reproduction is in general exclusively asexual, *H. drœbakensis* after a period of similar active asexual reproduction regularly enters a sexual phase, producing isogametes which on liberation conjugate to form zygotes. The whole process can be completed on agar and the resultant zygospores kept for months—at the time of writing I have a fresh series of active cultures raised from zygospores formed on agar last November. The alga is easily grown in culture, a rich growth being obtainable from the resting spores in a few days, and should prove invaluable to teachers of botany and biology as an example of a unicellular alga, for the study of both structure and behaviour and of reproduction by asexual and sexual methods.

Material was sent to Dr. E. F. Pringsheim, and I understand that *Hæmatococcus drœbakensis* has now been added to the collection of pure cultures of algæ maintained by him in the Botany School at Cambridge.

M. A. Pocock

Botany Department,
University of Cape Town,
May 5.

[1] Wollenweber, W., *Ber. der deutsch. bot. Gesell.*, **25**, 316 (1907); **26**, 238 (1908).

Changes in the Colour Sensitivity of the Eye with Posture

I refer to J. N. Aldington's letter in the issue of *Nature* of July 14.

My attention was directed to apparent change of colour sensitivity of the eye with its position by my sister—an artist. She pointed out to me that if the head were held sidewise, that is, with the line joining the eyes vertical instead of horizontal, all colours in a landscape appeared to be intensified. She was in the habit of using this aid in the course of her work.

On trying the method myself, I also noticed an intensification, and more particularly in the blue of a haze in the distance.

It may, of course, be the case that there is, in fact, no greater colour receptivity in the eye in this position, but that the attention is not so much distracted by form and detail in such circumstances and so colour gets a larger share of attention than it otherwise would have. The landscape certainly seemed more vague when viewed in this position.

The effects mentioned by Dr. J. N. Aldington in *Nature* of July 14, p. 86, and that described above are probably connected.

A. Blackie

Khandala Hotel,
Blackheath,
London, S.E.3.
July 19.

I was introduced some years ago, by a friend who lives in Cornwall, to a way of looking at the landscape by leaning as far to one side as possible. In this position after a short while the view takes on a much sharper impression, particularly hills and trees against the sky which appear to be seen in much greater detail.

The observation of J. N. Aldington (*Nature*, July 14, p. 86) that the colour sensitivity of the eyes differs when the two eyes are in different horizontal planes suggests a possible explanation of this phenomenon.

F. Taylor

Penwith,
The Close, Wilmington,
Dartford, Kent.
July 27.

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Tuesday, September 25—Thursday, September 27

DUBLIN INSTITUTE FOR ADVANCED STUDIES (in the School of Cosmic Physics, 5 Merrion Square, Dublin).—Colloquium on "Recent Advances in the Study of Cosmic Radiation".

Wednesday, September 26

PHYSICAL SOCIETY, COLOUR GROUP (in the Physics Department, Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 3 p.m.—Mr. H. G. W. Harding: Demonstration of a Visual and a Photoelectric Portable Colour Temperature Meter; Report on the Decisions reached, on matters of interest to the Colour Group, at the Stockholm Meeting of the Commission Internationale de l'Éclairage.

Wednesday, September 26—Friday, September 28

NATIONAL SMOKE ABATEMENT SOCIETY (at the Winter Gardens, Blackpool).—Eighteenth Annual Conference.

Thursday, September 27

INSTITUTION OF MINING AND METALLURGY (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. W. B. Roantree: "Work in High Air Temperatures in a Fire in Mysore Mine, Kolar Gold Field".

Thursday, September 27—Friday, September 28

SOCIETY OF CHEMICAL INDUSTRY, FOOD, AGRICULTURE and FINE CHEMICALS GROUPS (at the Wellcome Research Institution, 183–193 Euston Road, London, N.W.1), at 10.30 a.m. each day.—Conference on "Problems Arising from the Use of Chemicals in Food".

Friday, September 28

HOSPITAL PHYSICISTS' ASSOCIATION (in the Lecture Room, Department of Anatomy, The University, Downing Street, Cambridge), at 8.15 p.m.—Dr. L. H. Gray: "Actions of Radiations on Living Cells—1946 and After" (Second Douglas Lea Memorial Lecture)*.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

AREA SUPERVISOR (with a degree in science or the N.D.D. or N.D.D.H.) at Beverley, Halifax, Reading and Starcross, and an ASSISTANT AREA SUPERVISOR (with a degree in science or the N.D.D. or N.D.D.H.) at Newcastle-under-Lyme and Nottingham, in the National Milk Testing Service—The Secretary, Ministry of Agriculture and Fisheries, Room 406, 23–25 Soho Square, London, W.1 (September 29).

BIOCHEMIST FOR BIOCHEMICAL DEPARTMENT of the Group Laboratory—The Secretary, Stepney Group Hospital Management Committee, Raine Street, London, E.1 (September 29).

LECTURER IN PHYSICAL AND INORGANIC CHEMISTRY at the Rutherford College of Technology—The Director of Education, City Education Office, Northumberland Road, Newcastle-upon-Tyne 1 (September 29).

LECTURER TO TEACH PHYSICS to degree standard, and an ASSISTANT (Grade A) TO TEACH ELEMENTARY PHYSICS up to the standard of the General Certificate of Education (Advanced Level)—The Clerk to the Governors, Woolwich Polytechnic, Woolwich, London, S.E.18 (September 29).

PHYSICAL CHEMIST IN THE RESEARCH BRANCH, Chief Engineer's Department, London, to work in a small team engaged in research on the corrosion of steel at boiler pressures—The Secretary's Office (Establishments), Applications Section, British Electricity Authority, British Electricity House, Great Portland Street, London, W.1, quoting AE/199 (September 29).

SENIOR EXPERIMENTAL OFFICERS, EXPERIMENTAL OFFICERS and ASSISTANT EXPERIMENTAL OFFICERS at Admiralty experimental establishments in the vicinity of London, Baldock, Greenock, Haslemere, Portsmouth, Rosyth and Weymouth: MECHANICAL ENGINEERS (Ref. C.632/50A) with research and development experience in light mechanisms, ELECTRICAL ENGINEERS (Ref. D.368/50A) with experience in telecommunications, radar, electronics or light electrical mechanisms, and PHYSICISTS (Ref. A.335/50A) interested in general physical problems, electronics or acoustics—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (September 29).

SENIOR LECTURER IN EXPERIMENTAL PHARMACOLOGY—The Secretary of University Court, The University, Glasgow (September 29).

SENIOR LECTURER or LECTURER IN MATHEMATICS at Gordon Memorial College, Khartoum—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (September 29).

LECTURER IN NUTRITION at the University of Otago (School of Home Science), New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (September 30).

ASSISTANT EXPERIMENTAL OFFICERS (including BIOLOGISTS) in various Government Departments and divided between (*a*) mathematical and physical sciences, (*b*) chemistry and metallurgy, (*c*) engineering subjects, and (*d*) miscellaneous (including, for example, geology, library and technical information services)—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting No. 3068 (October 1).

PLANT PATHOLOGIST to assist in the subediting and making of abstracts—The Director, Commonwealth Mycological Institute, Ferry Lane, Kew, Surrey (October 1).

PROFESSIONAL ENGINEERS (general service class, main and senior grades) in Government Departments (at present in the Admiralty and in the Prison Commission)—The Secretary, Civil Service Commission, Trinidad House, Old Burlington Street, London, W.1, quoting No. S.86/51 (October 1).

PRINCIPAL SCIENTIFIC OFFICER (with a first- or second-class honours degree in physics, and knowledge of electro-acoustics and electronics with experience in the planning of research) at the R.A.F. Acoustics Laboratory—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting No. S.4063/51 (October 4).

PROFESSOR OF VETERINARY MEDICINE, PHARMACOLOGY AND MEAT INSPECTION at the Veterinary College, Dublin—The Secretary, Civil Service Commission, 45 Upper O'Connell Street, Dublin (October 5).

SCIENTIST, Grade III (with an honours degree in either geology or botany) IN THE COAL SURVEY LABORATORY at Sheffield for work on the palæobotany of coal and the correlation of seams—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/374 (October 13).

SCIENTISTS, Grade III (with honours degree in chemistry), IN THE COAL SURVEY LABORATORIES at Chester and Newcastle-upon-Tyne—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/376 (October 13).

SENIOR RESEARCH OFFICERS (2) IN THE SECTION OF METEOROLOGICAL PHYSICS, Highett, Victoria (one officer will engage in studies of the general circulation of the atmosphere, the other in problems of a dynamic-synoptic nature)—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 3554 (October 13).

SENIOR MARKETING OFFICER (with a university degree in horticulture or agriculture, and wide experience of commercial methods of marketing horticultural or agricultural produce, including livestock)—The Secretary, Department of Agriculture for Scotland (Room 266), St. Andrew's House, Edinburgh 1 (October 15).

ELECTRICAL INSPECTOR OF MINES AND QUARRIES—The Secretary, Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4075/51 (October 25).

LECTURER (with a degree in biochemistry and/or organic chemistry, and experience in the analysis of foods, including dairy products) IN AGRICULTURAL BIOCHEMISTRY (Dairy Chemistry) at the Massey Agricultural College, Palmerston North, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 31).

CHAIR OF PHYSICAL CHEMISTRY in the University of Sydney—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (November 12).

ASSISTANT EXPERIMENTAL OFFICER (with degree or diploma in agriculture, and practical knowledge of general farming) with aptitude for clear and concise self-expression in writing, and an ASSISTANT (Scientific), with practical farming experience and experience of handling machines in the field—The Secretary, National Institute of Agricultural Engineering, Wrest Park, Silsoe, Beds.

BIOLOGIST (with good honours degree) for radio-biological research laboratory—The Secretary, South Manchester Hospital Management Committee, Christie Hospital and Holt Radium Institute, Manchester 20.

CHEMICAL ENGINEERS (Principal Scientific Officer grade) at a Ministry of Supply research and development establishment—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, [quoting F.651/51A.

CHEMIST mainly for research analytical work—The Director of Research, Research Council of the British Whiting Federation, 245 Ampthill Road, Bedford.

CHEMISTS (Principal Scientific Officer grade) at a Ministry of Supply research and development establishment near London—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.640/51A.

CHEMIST (Ref. K2) to look after certain aspects of field trials work and to carry out research connected with it, two SCIENTISTS (Ref. K5–K6) to assist in planning of field trials, preparation of reports, and interpretation of data; some knowledge of mathematics required, and a MATHEMATICIAN (Ref. K7) to carry out statistical analysis; experience in probit analysis preferred, for a Research and Field Testing programme of the Defence Research Board—The Chief Superintendent, Suffield Experimental Station, Ralston, Alberta, Canada, quoting the appropriate Ref. No.

CHIEF TECHNICAL ENGINEER to take charge of an engineering section responsible for all the major calculations involved in the design and construction of factories for producing fissile material—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

CIVIL ENGINEERS, SANITARY ENGINEERS and STRUCTURAL ENGINEERS in a number of Departments in England and Scotland—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting 3405.LA (December 31).

DEMONSTRATOR IN PHARMACEUTICS—The Registrar, The University, Nottingham.

DEPUTY CHIEF ENGINEER for the Central Electrification Scheme in Cyprus—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.28858.B.

MATHEMATICIAN (with Ph.D. degree in mathematics, or equivalent), to be responsible for mathematical research of a semi-theoretical nature and to act as a consultant to members of a research group—The Director of Research Personnel, Defence Research Board, Department of National Defence, 'A' Building, Ottawa, Canada, quoting No. H-12.

PHYSICIST or PHYSICAL CHEMIST for work on fundamental problems associated with the hardening of Portland cement—The Cement and Concrete Association, 52 Grosvenor Gardens, London, S.W.1.

PROFESSOR AND HEAD OF THE DEPARTMENT OF ELECTRICAL ENGINEERING (Heavy), Indian Institute of Technology, Kharghpur, B.N.Ry., India—The Ministry of Labour and National Service, Technical and Scientific Register (A.S.12), York House, Kingsway, London, W.C.2, quoting A.12/UNE/150/51.

SENIOR SCIENTIFIC OFFICERS and SCIENTIFIC OFFICERS (posts are in various Government Departments covering a wide range of scientific research and development in most of the major fields of fundamental and applied science)—The Secretary, Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting No. 3399.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

General Register Office. Studies on Medical and Population Subjects, No. 4: Hospital Morbidity Statistics, a Preliminary Study of In-Patient Discharges. By Dr. Donald Mackay. Pp. 114. (London: H.M. Stationery Office, 1951.) 3*s*. net. [197

Memoirs of the Geological Survey of Great Britain. The Mesozoic Ironstones of England: The Northampton Sand Ironstone; Stratigraphy, Structure and Reserves. By Dr. S. E. Hollingworth and Dr. J. H. Taylor, with contributions by Dr. W. D. Evans, G. A. Kellaway, Dr. F. B. A. Welch, Dr. Vernon Wilson and Dr. A. W. Woodland. Pp. viii+211+6 plates. (London: H.M. Stationery Office, 1951.) 17*s*. 6*d*. net. [237

Annual Report of the British Welding Research Association, 1950–51. Pp. 40. (London: British Welding Research Association, 1951.) [247

British Standard 1715: 1951, Methods for the Analysis of Soaps. Pp. 42. (London: British Standards Institution, 1951.) 5*s*. net. [247

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 869, Vol. 243: On the Geometry of Numbers of Non-Convex Star-Regions with Hexagonal Symmetry. By R. P. Bambah. Pp. 431–462. 7*s*. 6*d*. No. 870, Vol. 243: A Study of the Reactions that lead to 'knock' in the Spark-Ignition Engine. By D. Downs, A. D. Walsh and R. W. Wheeler. Pp. 463–524. 17*s*. (London: Cambridge University Press, 1951.) [247

Forestry Commission. Britain's Forests—Cannock Chase. Pp. 16. 9*d*. net. Guide to the National Pinetum and Forest Plots at Bedgebury. Pp. iv+66+8 plates. 2*s*. 6*d*. net. Thirty-first Annual Report of the Forestry Commissioners for the Year ending September 30th, 1950. Pp. 75. 2*s*. 6*d*. net. (London: H.M. Stationery Office, 1951.) [247

Fitzwilliam Museum, Cambridge. Annual Report for the Year ending 31 December 1950. Pp. 10+4 plates. Friends of the Fitzwilliam Museum. Forty-second Annual Report for the Year 1950. Pp. 8. (Cambridge: Fitzwilliam Museum, 1951.) [247

Report of the Second Conference of Industrial Research Directors and Managers: the Planning and Financial Control of Industrial Research. Organized by the F.B.I. Industrial Research Committee and held at Ashorne Hill, Leamington Spa, 10 to 12 November 1950. Pp. 88. (London: Federation of British Industries, 1951.) 3*s*. [247

Department of Scientific and Industrial Research: Technical Information and Documents Unit. A Bibliographical Survey of the Development and Use of Substitute Materials for Non-Ferrous Metals and Alloy Steels in Germany. (Report No. RM8-2.) Pp. ii+46. (London: H.M. Stationery Office, 1951.) 1*s*. 6*d*. net. [257

Scottish Seaweed Research Association. Annual Report for 1950. Pp. 36. (Inveresk: Institute of Seaweed Research, 1951.) [257

Fourth Annual Report of the Advisory Council on Scientific Policy (1950–1951). Pp. 18. (London: H.M. Stationery Office, 1951.) 9*d*. net. [18

Government Scientific Organization in the Civilian Field. Pp. 47. (London: H.M. Stationery Office, 1951.) 1*s*. 6*d*. net. [18

British Museum (Natural History). John Murray Expedition 1933–34. Scientific Reports, Vol. 9, No. 4: The Epibionts and Parasites of the Planktonic Copepoda of the Arabian Sea. By Lieut.-Colonel R. B. Seymour Sewell. Pp. 255–394. (London: British Museum (Natural History), 1951.) 25*s*. [18

Ministry of Fuel and Power. Reports of H.M. Inspectors of Mines for the Year 1950—West Midland and Southern Division. Report by H. S. S. Scott. Pp. ii+22+5 plates. (London: H.M. Stationery Office, 1951.) 1*s*. 6*d*. net. [18

World Power Conference. Annual Report 1950. Pp. 22. (London: World Power Conference, 1951.) [18

The New Race. By a Disciple of Darwin. Pp. 24. (London: William Margrie, 24 Nigel Road, S.E.15, 1951.) 2*s*. 6*d*. [18

The Industrial Use of Flash Welding, dealing in particular with Ferrous Materials. (T.27.) Pp. 31. (London: British Welding Research Association, 1951.) 2*s*. 6*d*. [18

City and County of Bristol: The City Museum. Report of the Committee for the Year ended 31 December 1950. Pp. 16+4 plates. (Bristol: City Museum, 1951.) [28

Annual Reports on the Progress of Chemistry for 1950. Vol. 47. Pp. 490. (London: Chemical Society, 1951.) 25*s*. [28

Other Countries

Elephas maximus, the Elephant of Ceylon. By P. E. P. Deraniyagala. Vol. 1. Pp. 48+18 plates. (Colombo: National Museum, 1951.) 50 cents; 1*s*. [177

Distribution of British Pharmacopœial Drug Plants and their Substitutes Growing in India. By S. L. Nayar and I. C. Chopra. Pp. 56. (New Delhi: Council for Scientific and Industrial Research, 1951.) 1.4 rupees. [177

German Hydrographic Institute. Annual Report No. 5, 1950. Pp. 70+11 plates. (Hamburg: German Hydrographic Institute, 1951.) [177

Publications de l'Institut National pour l'Etude Agronomique du Congo Belge. Série scientifique, No. 49: Observations sur les réactions du cotonnier aux conditions de milieu. Par M. Lecomte, R. de Coene et F. Corcelle. Pp. 56. (Bruxelles: Institut National pour l'Etude Agronomique du Congo Belge, 1951.) 70 francs. [177

Indo-Pacific Fisheries Council. List of Scientific and other Periodicals published in the Indo-Pacific Area. Pp. 32. (Bangkok: Indo-Pacific Fisheries Council, 1951.) [177

Southern Rhodesia. Report of the Director, Geological Survey, for the Year 1950. Pp. 6. (Salisbury: Government Printing and Stationery Office, 1951.) [177

Ontario Research Foundation. Annual Report, 1950. Pp. 24. (Toronto: Ontario Research Foundation, 1951.) [177

National Museum of Northern Rhodesia. The Rhodes-Livingstone Museum, 1934–1951. Pp. v+44. (Livingstone: Rhodes-Livingstone Museum, 1951.) 2*s*. [177

Cuatro conferencias sobre los Indios Fueguinos. Dictadas en la Universidad de Chile y editadis por Prof. Alejandro Lipschutz y Dra. Grete Mostny. Pp. xv+86. (Santiago: Revista Geografica de Chile, 1950.) [187

Peces de Chile: clave de determinacion de las especies importantes. Por Prof. Dr. Guillermo Mann F. Pp. 48. (Santiago: Ministerio de Agricultura, 1950.) [187

Queensland Institute of Medical Research. Fifth Annual Report, Year ended 30th June 1950. Pp. 16. (Brisbane: Queensland Institute of Medical Research, 1951.) [197

Annual Report of the Queen Victoria Museum and Art Gallery, 1949–1950. Pp. 8. (Launceston: Queen Victoria Museum and Art Gallery, 1951.) [197

Birds of Montezuma Castle and Tuzigoot National Monuments. By Henry H. Collins, Jr. Pp. ii+14. (Santa Fe, New Mexico: Southwestern Monuments Association, 1951.) 25 cents. [237

Development and Welfare in the West Indies. Bulletin No. 29: The Fisheries of British West Indies; Report on a Visit in 1949. By Dr. C. F. Hickling. Pp. 41. (Barbados: B.W.I. Development and Welfare Organization, 1950.) 20 cents. [247

Académie Royale de Belgique, Classe des Sciences. Mémoires, Tome 26, Fasc. 2: La méthode du Pentasphère oblique mobile et quelques-unes de ses applications. Par Prof. F. Backes. Pp. 87. (Bruxelles: Académie Royale de Belgique, 1951.) 80 francs. [247

Apia Observatory, Apia. Magnetic and Meteorological Results for 1948. Pp. iii+154. (Wellington, N.Z.: Government Printer, 1950.) [247

Publications of the Dominion Astrophysical Observatory. Vol. 8, No. 12: A Model Atmosphere for an Early O-Type Star. By Anne B. Underhill. Pp. 357–384. n.p. Vol. 8, No. 13: On the Luminosity Effects of the Hydrogen Lines in O-Type Spectra. By Anne B. Underhill. Pp. 385–400. 25 cents. Vol. 8, No. 14: Spectrographic Observations of Epsilon Ursæ Minoris. By J. L. Climenhaga, A. McKellar and R. M. Petrie. Pp. 401–408. 25 cents. Vol. 9, No. 1: The Spectra of the P Cygni Stars. By C. S. Beals. Pp. 138. n.p. (Ottawa: King's Printer, 1951.) [247

International Union of Theoretical and Applied Mechanics and International Astronomical Union. Problems of Cosmical Aerodynamics: Proceedings of the Symposium on the Motion of Gaseous Masses of Cosmical Dimensions held at Paris, August 16–19, 1949. Pp. viii+237. (Dayton, Ohio: Central Air Documents Office (Army-Navy-Air Force), 1951.) [257

East Africa High Commission: East African Fisheries Research Organization. Annual Report 1950. Pp. 25. (Nairobi: East Africa High Commission, 1951.) [257

Indo-Pacific Fisheries Council. Proceedings, 1st Meeting, 24th-31st March, 1949, Singapore. Pp. 143. (Bangkok: Indo-Pacific Fisheries Council, 1951.) [257

Nigeria. Annual Report on the Forest Administration of Nigeria for the Year 1949–50. Pp. 72. (Enugu: Government Printer; London: Crown Agents for the Colonies, 1951.) 6*d*. net. [257

Suomen Geodeettisen Laitoksen Julkaisuja. No. 39: On the World Geodetic System. By W. Heiskanen. Pp. 25. No. 40: The Motions of Moon and Sun at the Solar Eclipse of 1947, May 20th. By R. A. Hirvonen. Pp. 36. (Helsinki: Finnischen Geodätischen Institutet, 1951.) [267

Instituto Nacional de la Investigacion Cientifica. Estaciones de Biologia Marina para el mejor conocimiento, explotacion y conservacion de los recursos naturales, y por ende para fomentar el progreso de las ciencias naturales mexicanas. Por Prof. J. Joaquin Izquierdo. Pp. 22. (Mexico: Editorial E.C.L.A.L., 1951.) [267

Nigeria. Annual Report on the Agricultural Department for the Year 1949–50. Pp. 92. (Kaduna: Government Printer: London: Crown Agents for the Colonies, 1951.) 9*d*. net. [267

New Zealand Department of Scientific and Industrial Research: Christchurch Magnetic Observatory. Annual Reports for 1937, 1938, 1939. Pp. xiii+144. (Wellington: Government Printer, n.d.) [18

Apia Observatory, Apia. Annual Report for 1941. Pp. iv+170. (Wellington, N.Z.: Government Printer, 1950.) [18

Race and Psychology. By Prof. Otto Klineberg. (The Race Question in Modern Science Series: Publication 892.) Pp. 40. (Paris: Unesco; London: H.M. Stationery Office, 1951.) 1*s*. 6*d*. net. [18

The Roots of Prejudice. By Prof. Arnold Rose. (The Race Question in Modern Science Series: Publication 865.) Pp. 44. (Paris: Unesco; London: H.M. Stationery Office, 1951.) 1*s*. 6*d*. net. [18

United States Department of Commerce: Weather Bureau. Technical Paper No. 12: Sunshine and Cloudiness at Selected Stations in the United States, Alaska, Hawaii and Puerto Rico. Pp. iii+16. 15 cents. Technical Paper No. 15: Maximum Station Precipitation for 1, 2, 3, 6, 12 and 24 Hours. Part 1: Utah. Pp. ii+44. 25 cents. (Washington, D.C.: Government Printing Office, 1951.) [18

Chicago Natural History Museum. Report of the Director to the Board of Trustees for the Year 1950. Pp. 142. (Chicago: Chicago Natural History Museum, 1951.) 1 dollar. [18

Current Scientific Researches in Mellon Institute 1950–1951: the Thirty-eighth Annual Report of the President, E. R. Weidlein, to the Board of Trustees of the Institution, for the Fiscal Year ended February 28, 1951. Pp. iv+52. (Pittsburgh, Pa.: Mellon Institute, 1951.) [28

Smithsonian Institution: United States National Museum. Contributions from the United States National Herbarium, Vol. 31, Part 1: The Acanthaceæ of Colombia, 1. By Emery C. Leonard. Pp. vi+117. (Washington, D.C.: Government Printing Office, 1951.) 50 cents. [28

Beach Erosion Board: Corps of Engineers. Technical Memorandum No. 24: The Accuracy of Present Wave Forecasting Methods with reference to the Problems in Beach Erosion on the New Jersey and Long Island Coasts. By Willard J. Pierson, Jr. Pp. vi+76. (Washington, D.C.: Government Printing Office, 1951.) [28